Heavy Quark Production at the Tevatron

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On behalf of the D0 & CDF Collaborations

Heavy Quarks and Leptons, Puerto Rico, June 2004

In this talk…

A lot of analyses are in progress at the Tevatron, here not at all exhaustive summary!

- Cross-section measurements:
  - Prompt charm meson
  - Inclusive J/ψ
  - $b \rightarrow J/\psi X$
  - $\gamma + b/c$
- Exclusive measurements:
  - B hadron masses
  - CP asymmetries and decay rate ratios
  - Observation of narrow D** states in semileptonic B decays
  - B^0 mixing
  - Search for pentaquarks

- Not included:
  - B lifetimes (discussed in other sessions)
  - $BR(B_s \rightarrow D_s \pi)$
  - $BR(B^+ \rightarrow \phi K^+)$
  - $B_c \rightarrow J/\psi \mu X$ search
  - ………

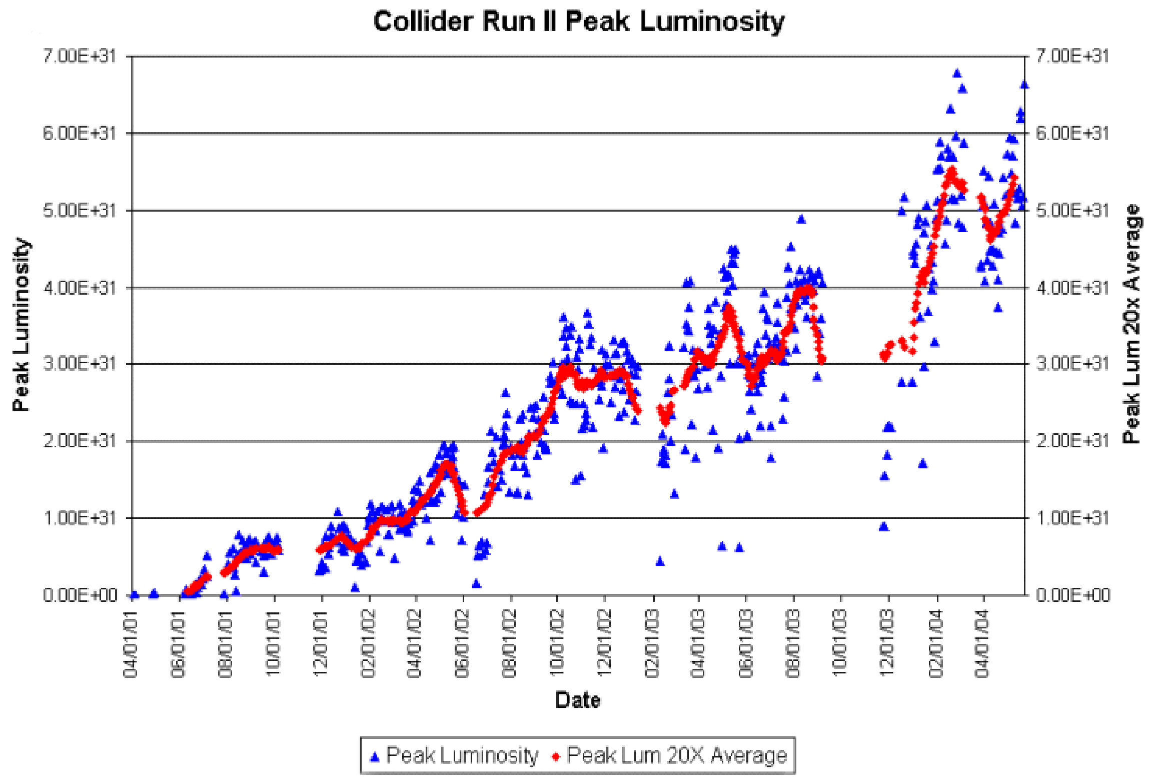
- Not included, but available in the back up slides:
  - $B_s \rightarrow \mu \mu$ search (discussed in other sessions)
  - $X(3872) \rightarrow J/\psi \pi \pi$ state (discussed in other sessions)
  - Two body charmless decays studies
  - B_s mixing sensitivity

Tevatron Performance

- The Tevatron is working quite well this year

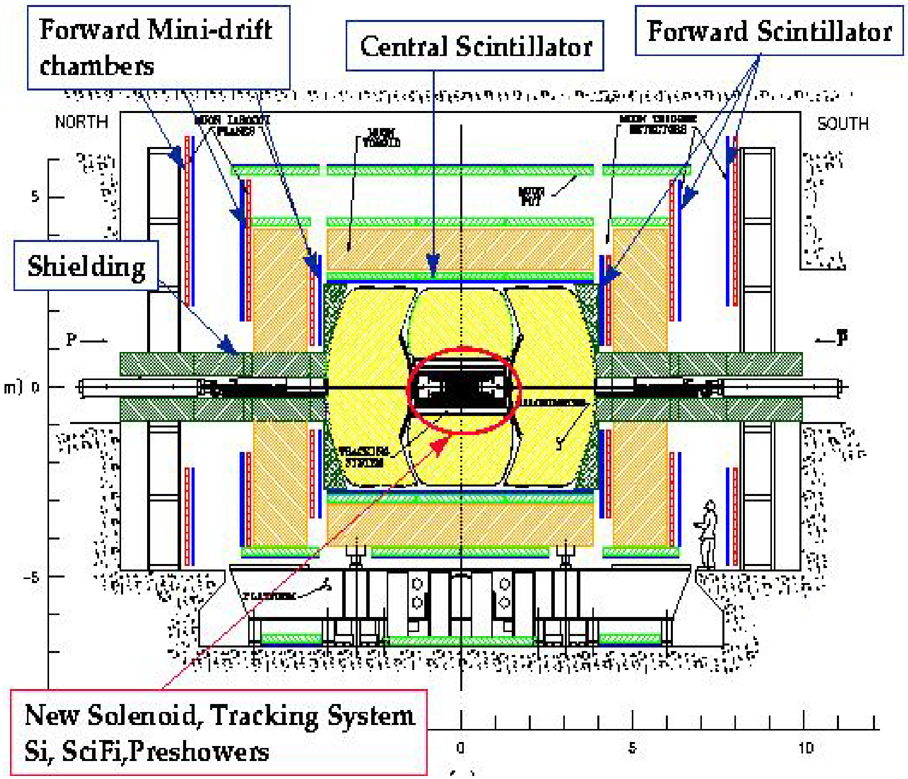
- Record Initial luminosity = 7.4 X 10^{31} sec^{-1} cm^{-2}

- Detector efficiency ~85-90%



~300 pb^{-1} on tape per experiment

Detectors

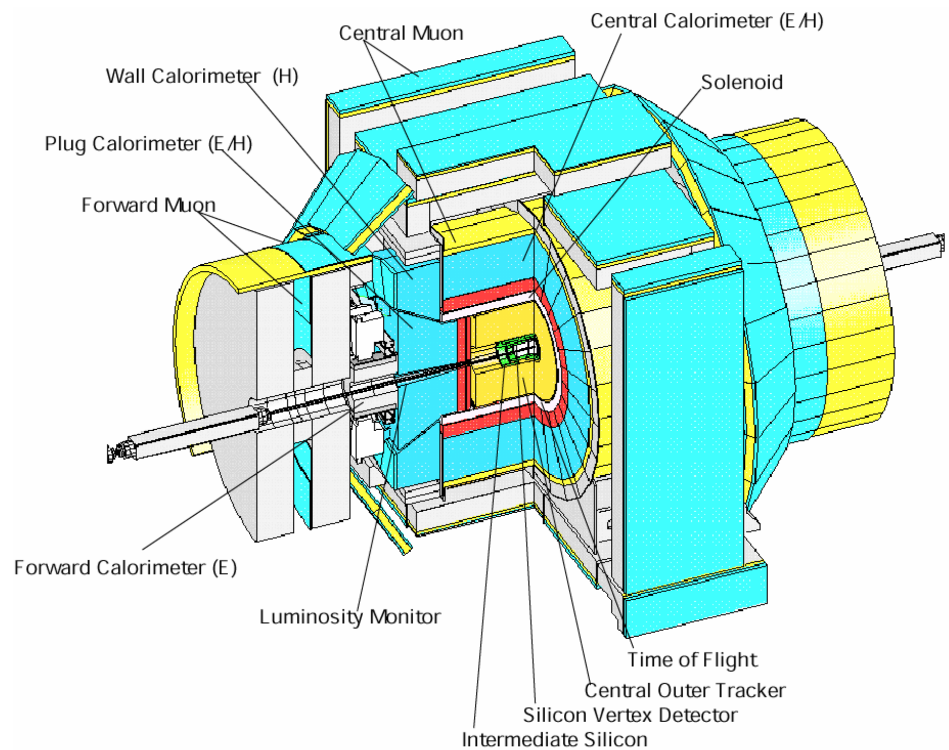


CDF

L2 trigger on displaced vertexes
Particle ID (TOF and dE/dx)
Excellent tracking resolution

DØ

Excellent muon ID and acceptance
Excellent tracking acceptance $|\eta| < 2\text{-}3$
L3 trigger on impact parameter/L2 impact parameter trigger being commissioned

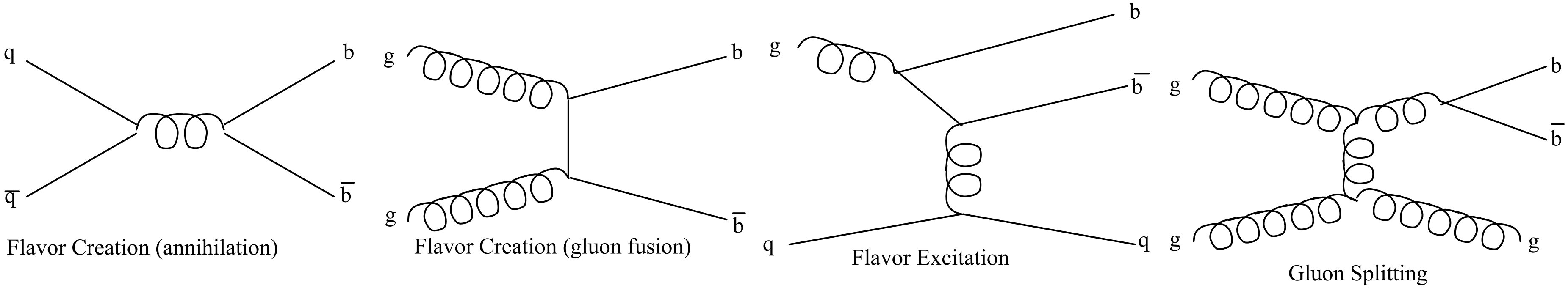


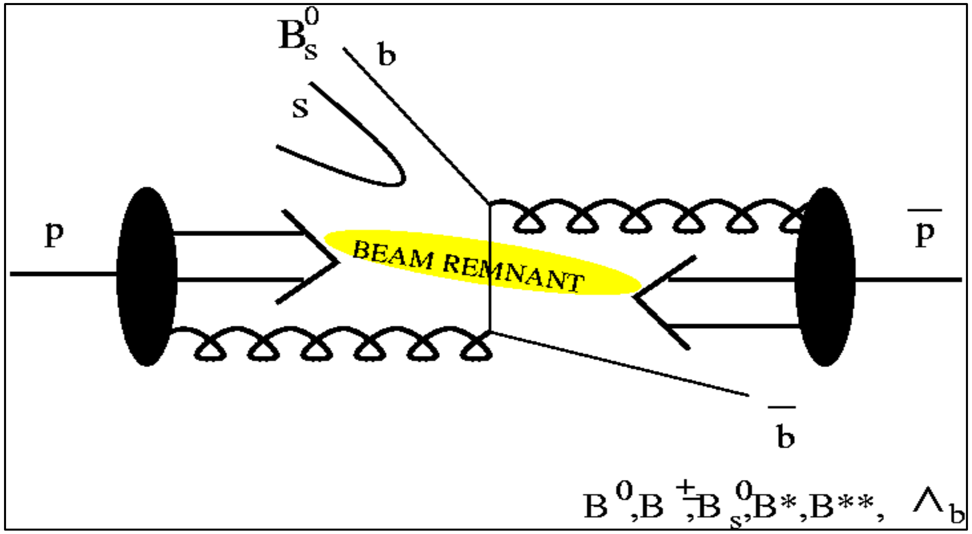
Both detectors

Silicon microvertex tracker
Axial solenoid
Central tracking
High rate trigger/DAQ
Calorimeters and muons

Heavy Flavor Physics at the Tevatron

B Bbar production mechanics in hadron collider:





- Huge Charm and Bottom cross-sections
- All *B* species produced:

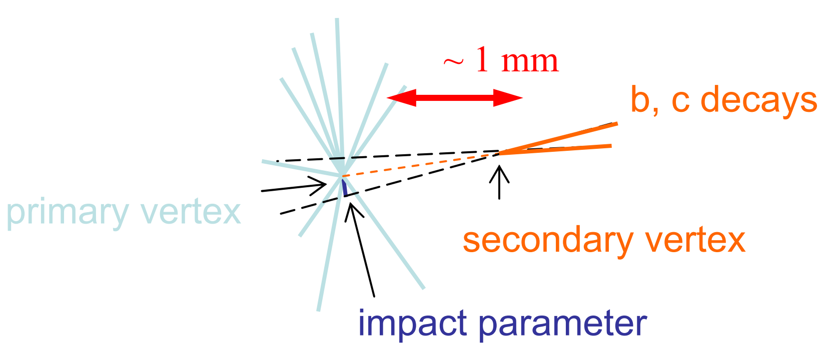
  $-B_u, B_d, \mathbf{B_s}, \mathbf{B_c}, \Lambda_b, \ldots$

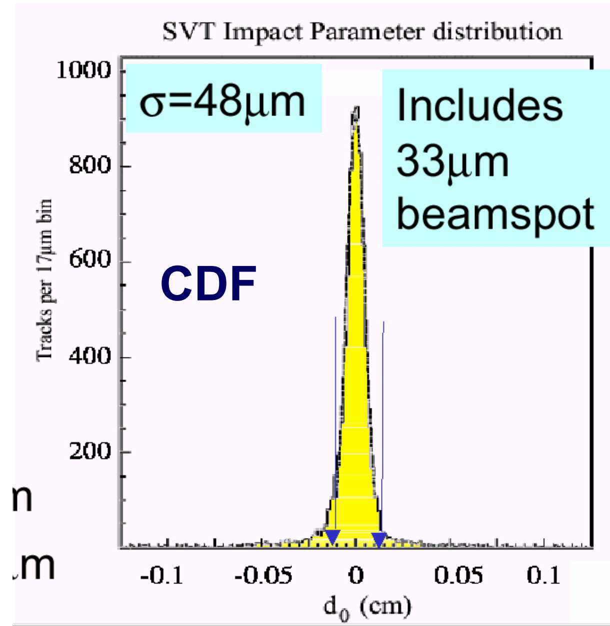
BUT $\sigma(bb) \ll \sigma(pp)$ $\Rightarrow$ **B/C events have to be selected with specific triggers…**

Trigger requirements: large bandwidth, background suppression, deadtimeless

Heavy Flavor Triggers

- Single/di-lepton (CDF/D0)
  High p_T lepton or two leptons with lower p_T
  - J/ψ modes, masses, lifetime, x-section
  - Yields higher than Run I (low Pt threshold, increased acceptance)
- lepton + displaced track - semileptonic sample (CDF)
  - $p_T(e/\mu) > 4$ GeV/c, 120 μm < d0(Trk) < 1mm, $p_T(Trk) > 2$ GeV/c
  - Semileptonic decays, Lifetimes, flavor tagging
  - B Yields 3x Run I
- Two displaced vertex tracks - hadronic sample (CDF)
  - $p_T(Trk) > 2$ GeV/c, 120 μm < d0(Trk) < 1mm, $\Sigma p_T > 5.5$ GeV/c
  - X-section, branching ratios, B_s mixing…



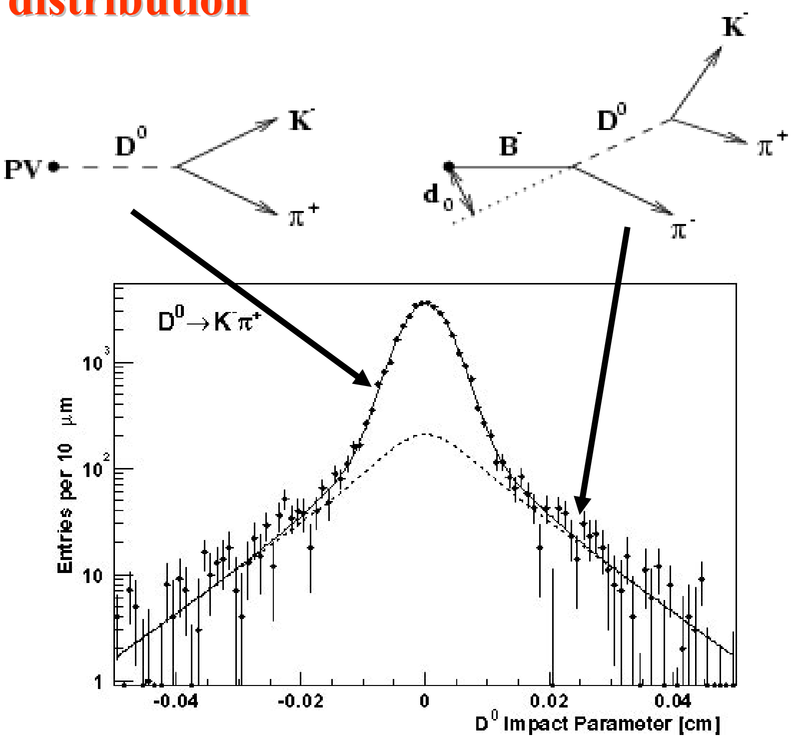


INCLUSIVE CROSS-SECTION MEASUREMENTS

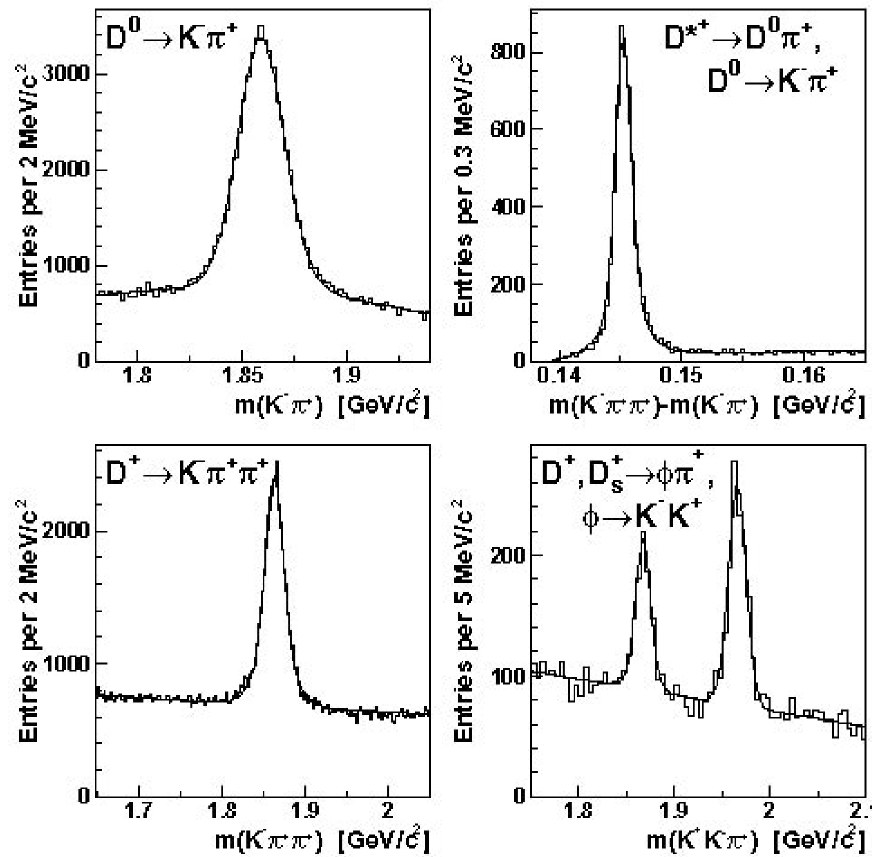
Prompt Charm Meson X-Section

- Measure prompt charm meson production cross section using the CDF Two Track Trigger
- Large and clean signal Measurement **not** limited by statistics

Separate prompt and secondary charm based on their **impact parameter distribution**



Tail due to B→D



Direct Charm Meson Fraction:

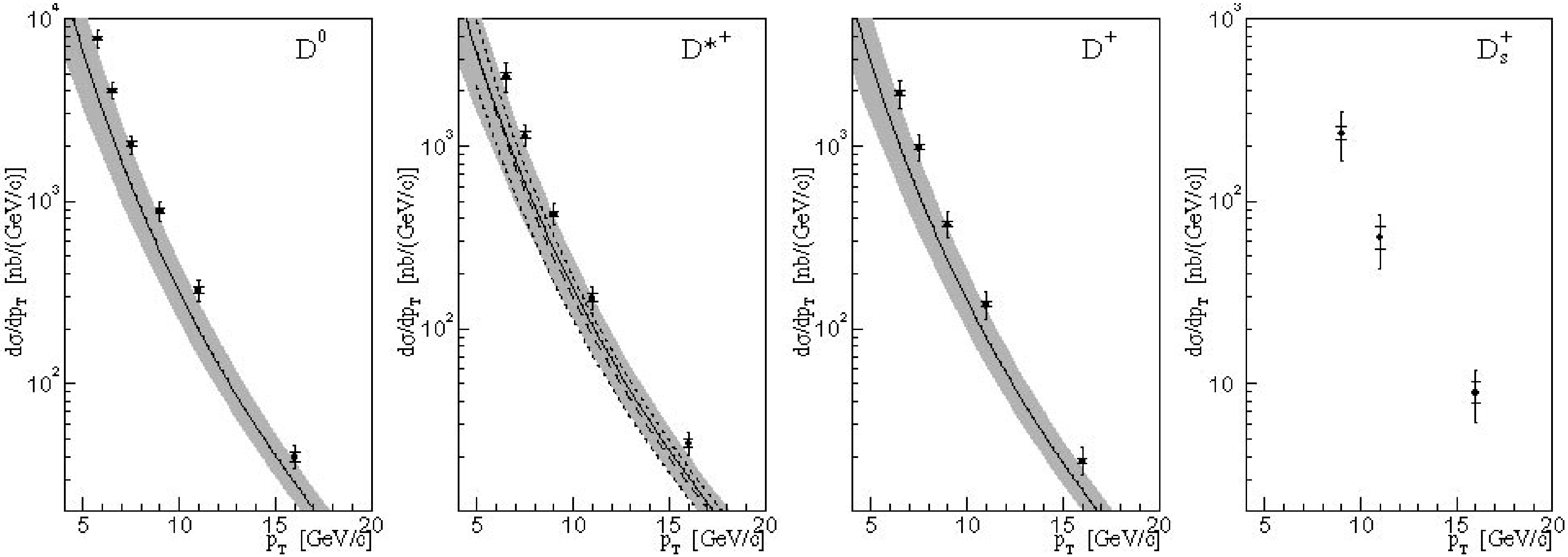
D^0: f_D=86.5±0.4±3.5%

D^{*+}: f_D=88.1±1.1±3.9%

D^+: f_D=89.1±0.4±2.8%

D^+_s: f_D=77.3±4.0±3.4%

Prompt Charm Meson X-Section



Calculation from M. Cacciari and P. Nason: Resummed perturbative QCD (FONLL)
JHEP 0309,006 (2003)

CTEQ6M PDF
M_c=1.5 GeV,
Fragmentation: ALEPH measurement
Renorm. and fact. Scale: $m_T=(m_c^2+p_T^2)^{1/2}$
Theory uncertainty: scale factor 0.5-2.0

$$\sigma(D^0, p_T \geq 5.5\mathrm{GeV}, |Y| \leq 1) = 13.3 \pm 0.2 \pm 1.5 \mu b$$

$$\sigma(D^{*+}, p_T \geq 6\mathrm{GeV}, |Y| \leq 1) = 5.2 \pm 0.1 \pm 0.8 \mu b$$

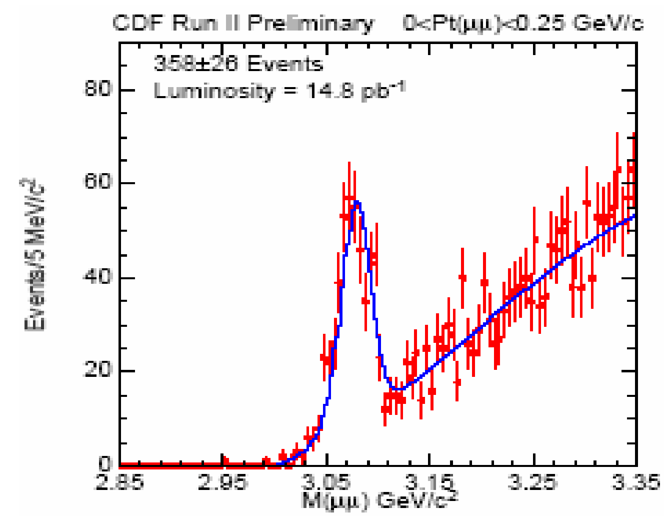
$$\sigma(D^+, p_T \geq 6\mathrm{GeV}, |Y| \leq 1) = 4.3 \pm 0.1 \pm 0.7 \mu b$$

$$\sigma(D_s^+, p_T \geq 8\mathrm{GeV}, |Y| \leq 1) = 0.75 \pm 0.05 \pm 0.22 \mu b$$

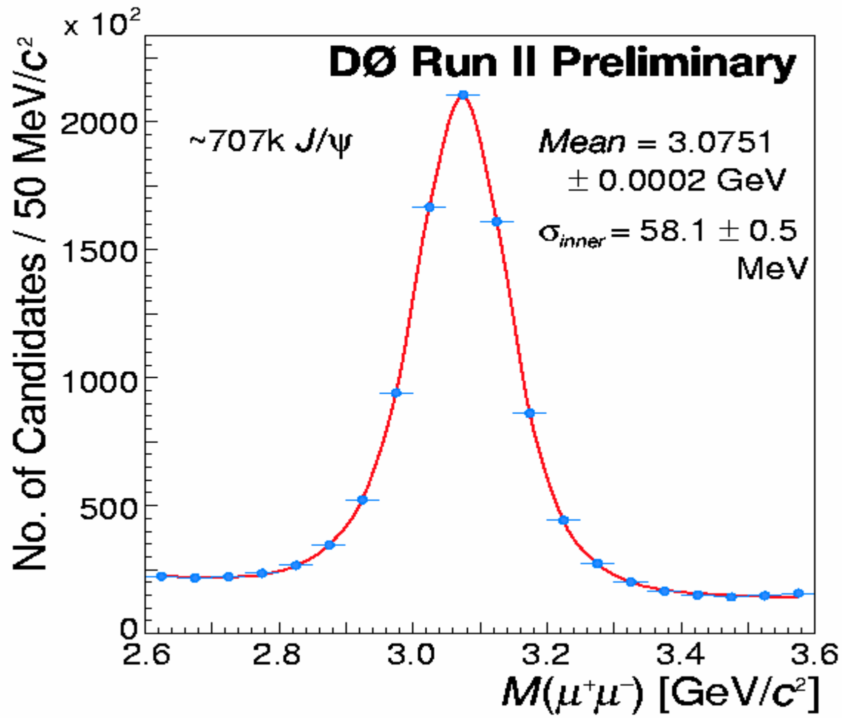
Inclusive J/ψ X-Section

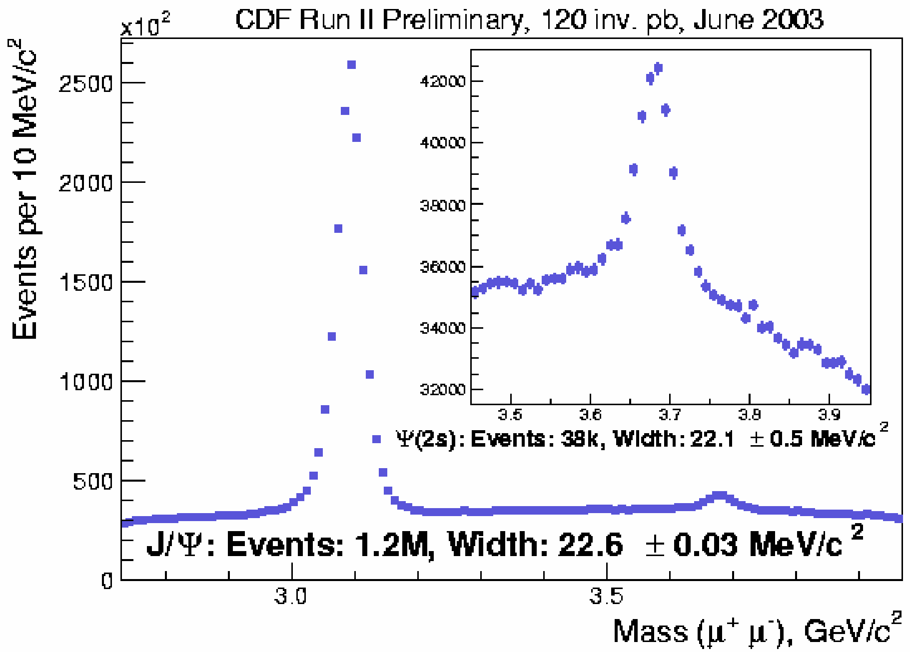
CDF: Lower p_T trigger threshold for μ: $p_T(\mu) \geq 1.5$ GeV

J/ψ acceptance down to p_T=0



D0: Larger acceptance for μ



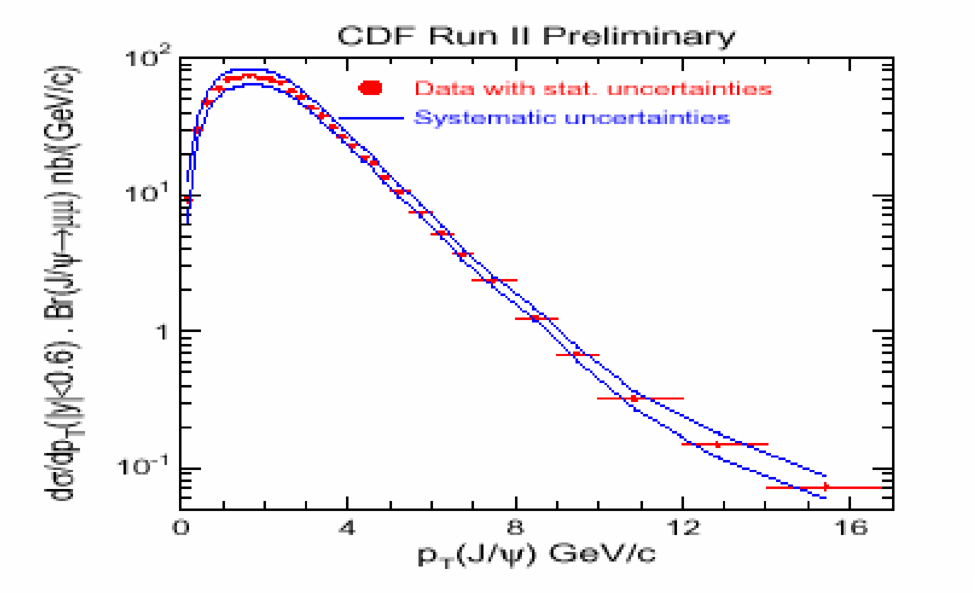


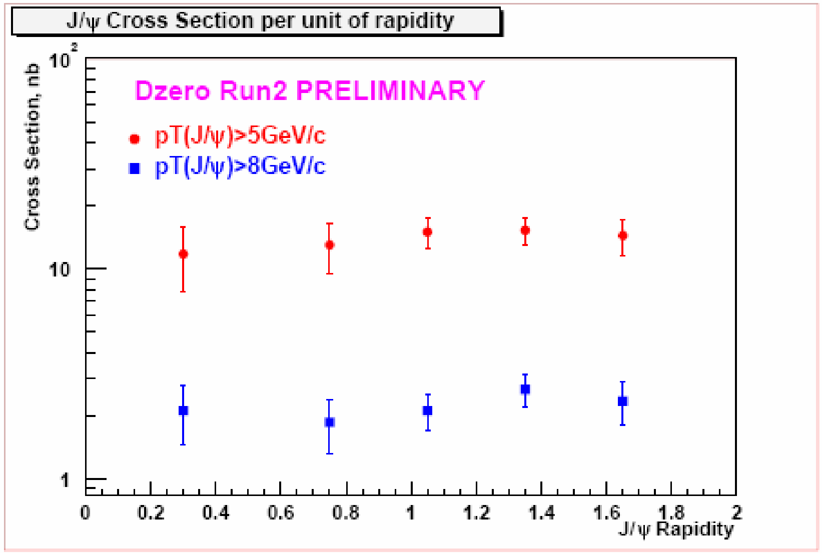
Inclusive J/ψ X-Section

$$\sigma(p\bar{p} \to J/\Psi X, |y(J/\Psi)| < 0.6) = 4.08 \pm 0.02(stat)^{+0.60}_{-0.48}(syst)\mu b$$

CDF: 39.7 pb^{-1}

D0: 4.8 pb^{-1}



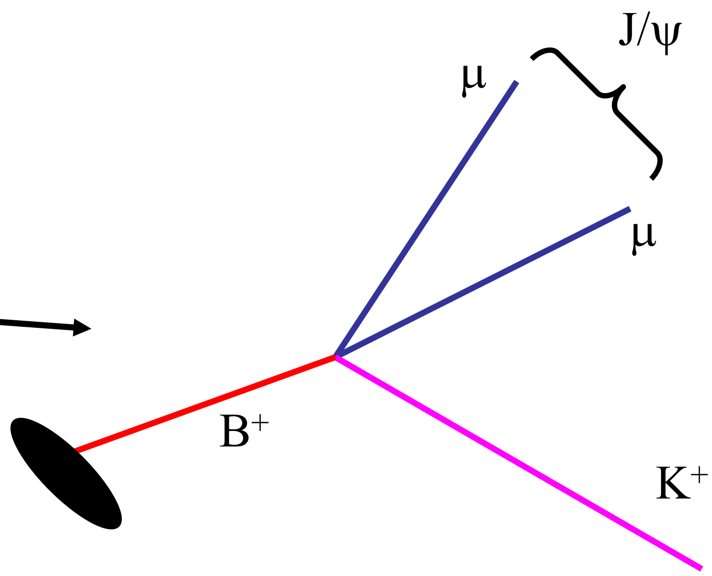


Extract Contribution from b $\rightarrow$ J/ψ X

The J/ψ inclusive cross-section includes contribution from

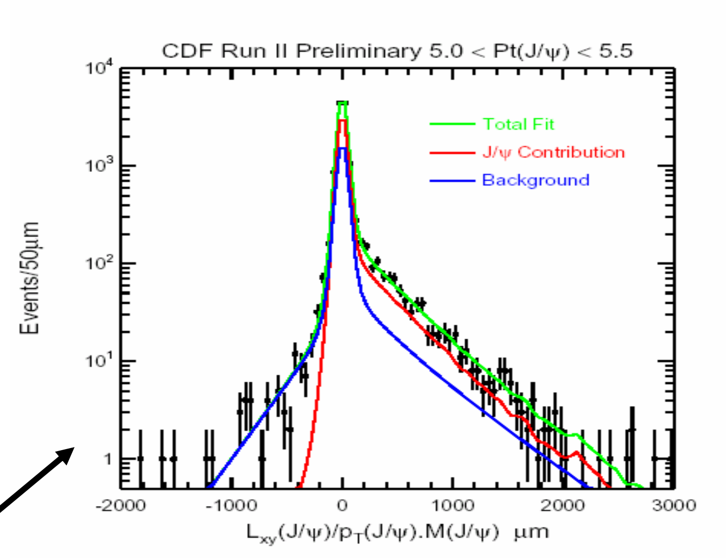
- Direct production of J/ψ
- Decays from excited charmonium: $\Psi(2S) \rightarrow J/\psi\ \pi^+\pi^-$, …
- Decays of b-hadrons: B $\rightarrow$ J/ψ X, …

b hadrons have long lifetime,
J/ψ decayed from b hadrons
Will be displaced from primary
Vertex!



Inclusive b X-Section (CDF)

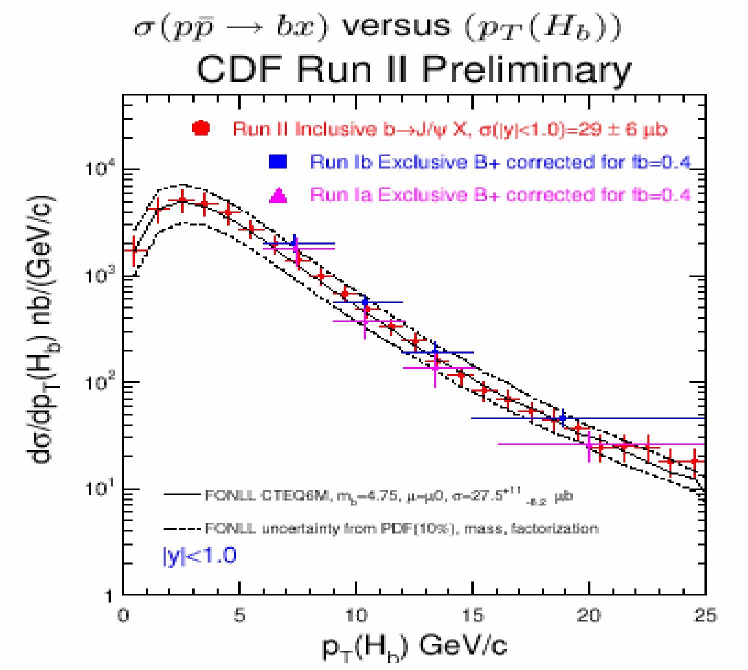
- RunI b cross-section ~ 3x old NLO QCD
- Theoretical approaches: new physics, Next-to-Leading-log resummations, non perturbative fragmentation function from LEP, new factorization schemes…
- An unbinned maximum likelihood fit to the flight path of the J/ψ in the r-ϕ plane to extract the b fraction



Bottom Quark Production cross-section:

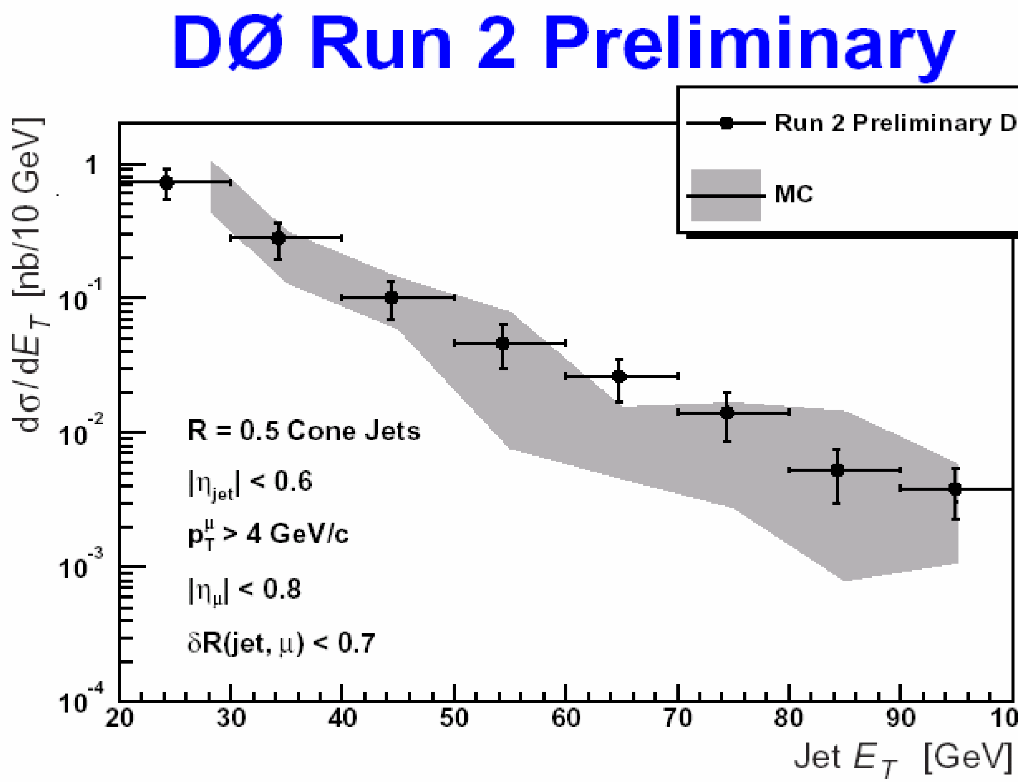
$$\sigma(p\bar{p} \to bX)|_{|y|<1.0} = (29.4 \pm 0.6(stat) \pm 6.2(sys))\ \mu b$$

$$\textbf{FONLL}\ \sigma(p\bar{p} \to bX)|_{|y|<1.0} = (27.5^{+11}_{-8.2})\ \mu b$$



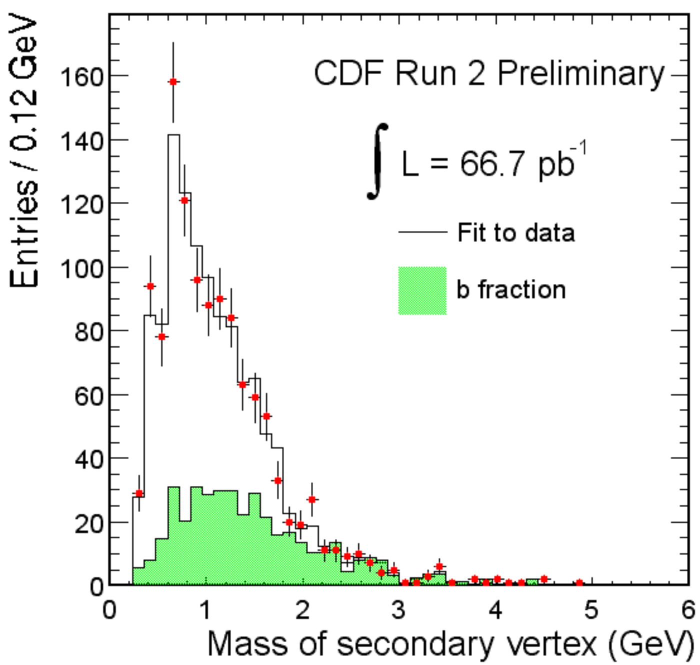
Inclusive b X-Section (D0)

μ + jet sample → Using μ p_T spectrum to fit the b and non b content as a function of jet E_T

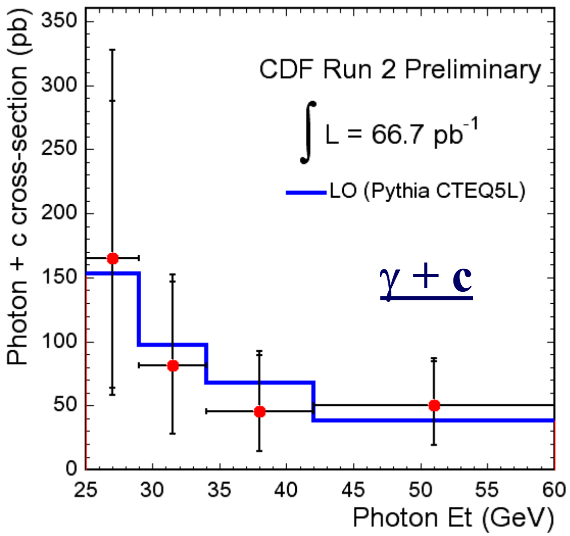


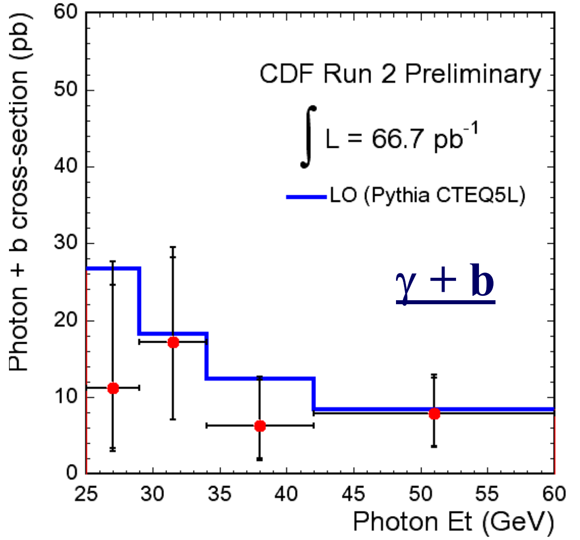
γ + b/c X-Section

- It probes the heavy flavor content of the proton, sensitive to new Physics
- Basic requirements:
  - One isolated and High E_t γ (> 25 GeV)
  - One jet with a secondary vertex (b/c "like" jet)
- Fit on the secondary vertex mass distribution of the tagged jets to determine the number of events containing b, c and uds quarks in the data



Overall fit





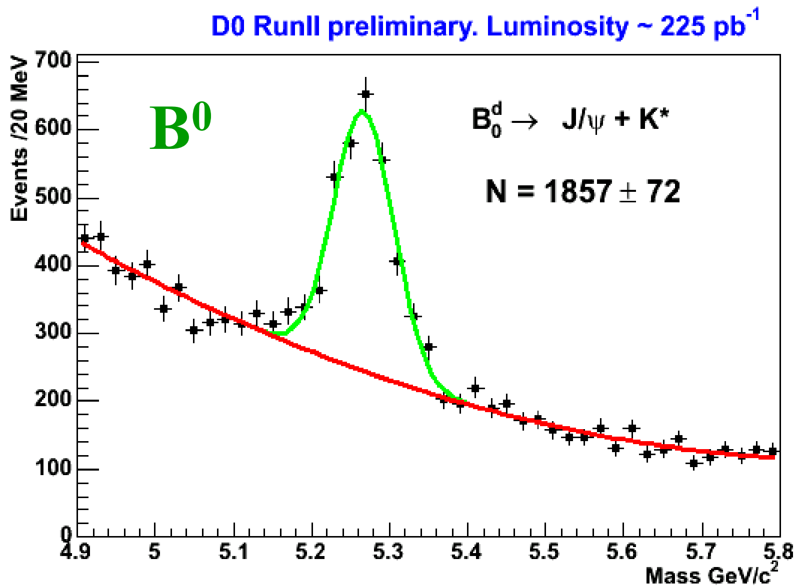
Cross-section measurements agree with the QCD predictions

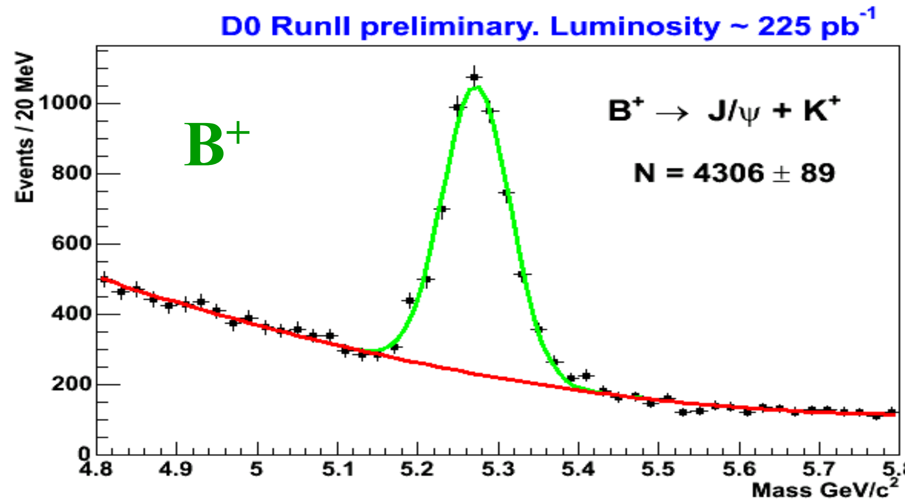
$\sigma(b + \gamma)$ = 40.6 +/- 19.5 (stat.) + 7.4 -7.8 (sys.) pb
$\sigma(c + \gamma)$ = 486.2 +/- 152.9 (stat.) + 86.5 -90.9 (sys.) pb

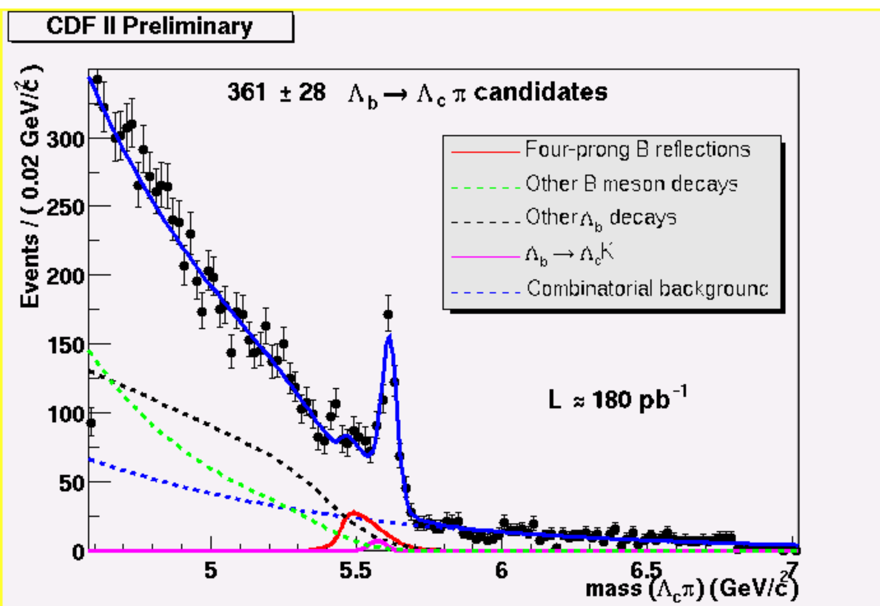
Once the overall picture is under control,
I will talk about some recent measurements from exclusive modes…

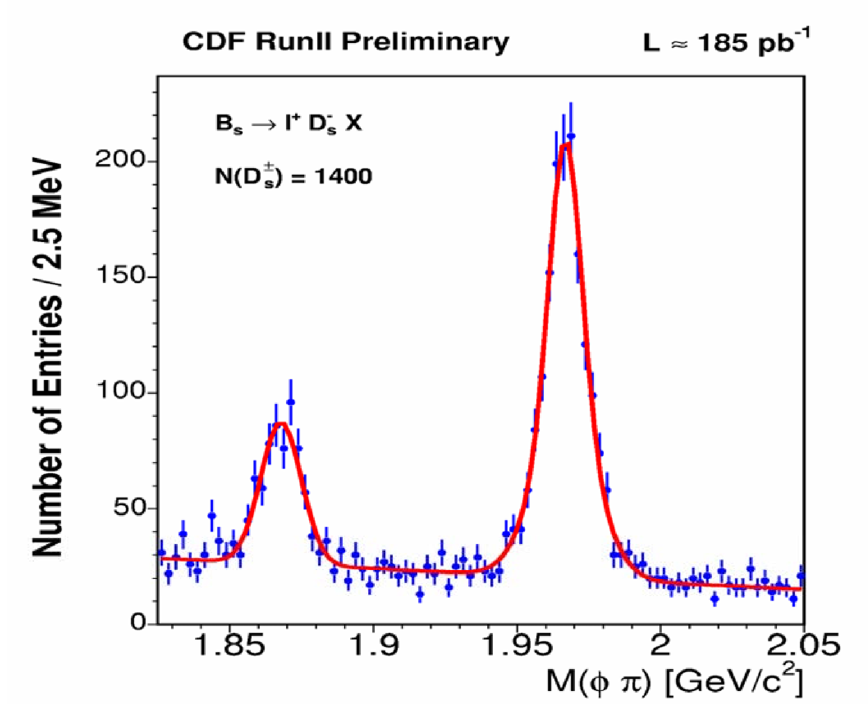
Results from ‘exclusive’ channels

Yields in Exclusive B Decays

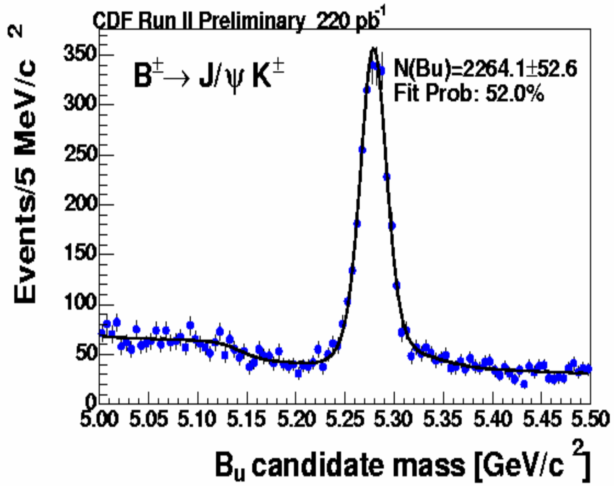


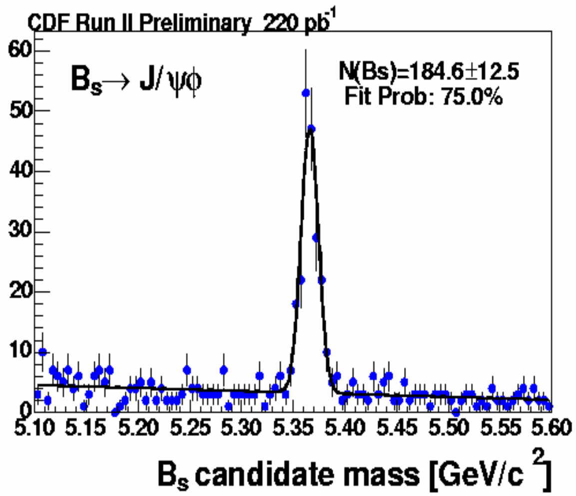


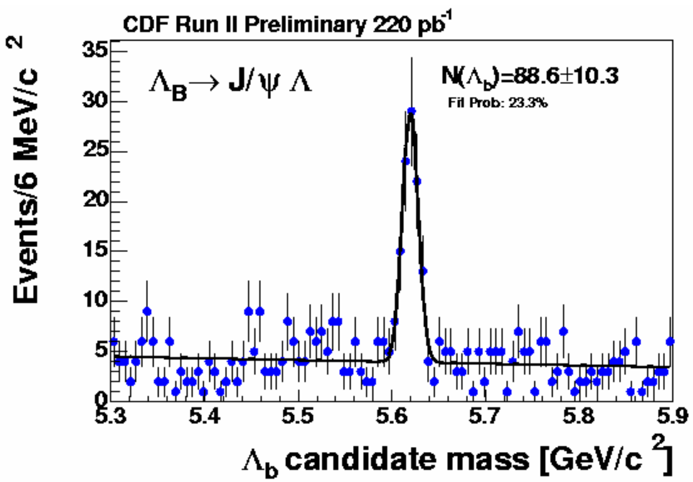




B masses in Exclusive J/ψ channels



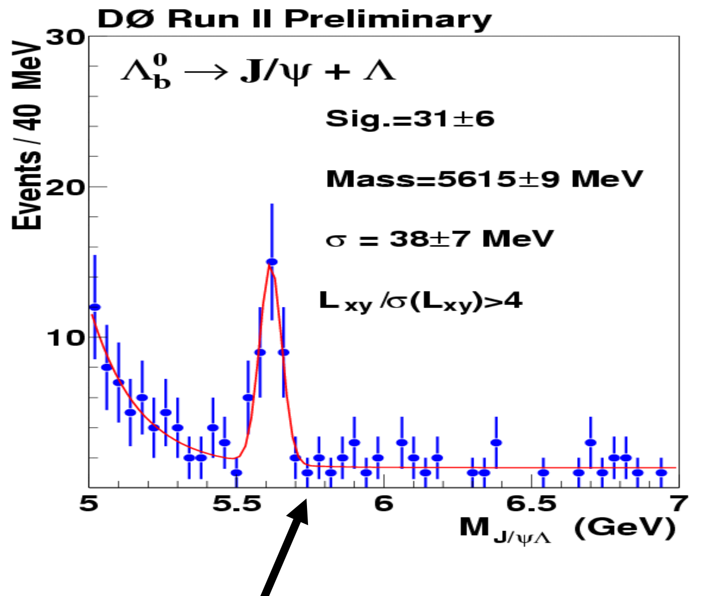




Mass measurements in fully reconstructed B decays:

- Small systematic uncertainties
- Best B^+ and B^0 single measurements
- Best B_s and Λ_b w.r.t the combined PDG

Results in Mev/c²	CDF preliminary	PDG value
B^+	5279.10 ± 0.41 ± 0.34	5279.0 ± 0.5
B^0	5279.57 ± 0.53 ± 0.30	5279.4 ± 0.5
B_s	5366.01 ± 0.73 ± 0.30	5369.6 ± 2.4
Λ_b	5619.7 ± 1.2 ± 1.2	5624 ± 9



To be reprocessed with extended tracking ⇒ improve yield by 50%

CP Asymmetries and Decay Rate Ratios

• The huge amount data collected by the CDF Two Track Trigger have been used for this analysis

Relative branching ratios:

$\Gamma(D^0 \rightarrow K^+K^-) / \Gamma(D^0 \rightarrow K\pi)$

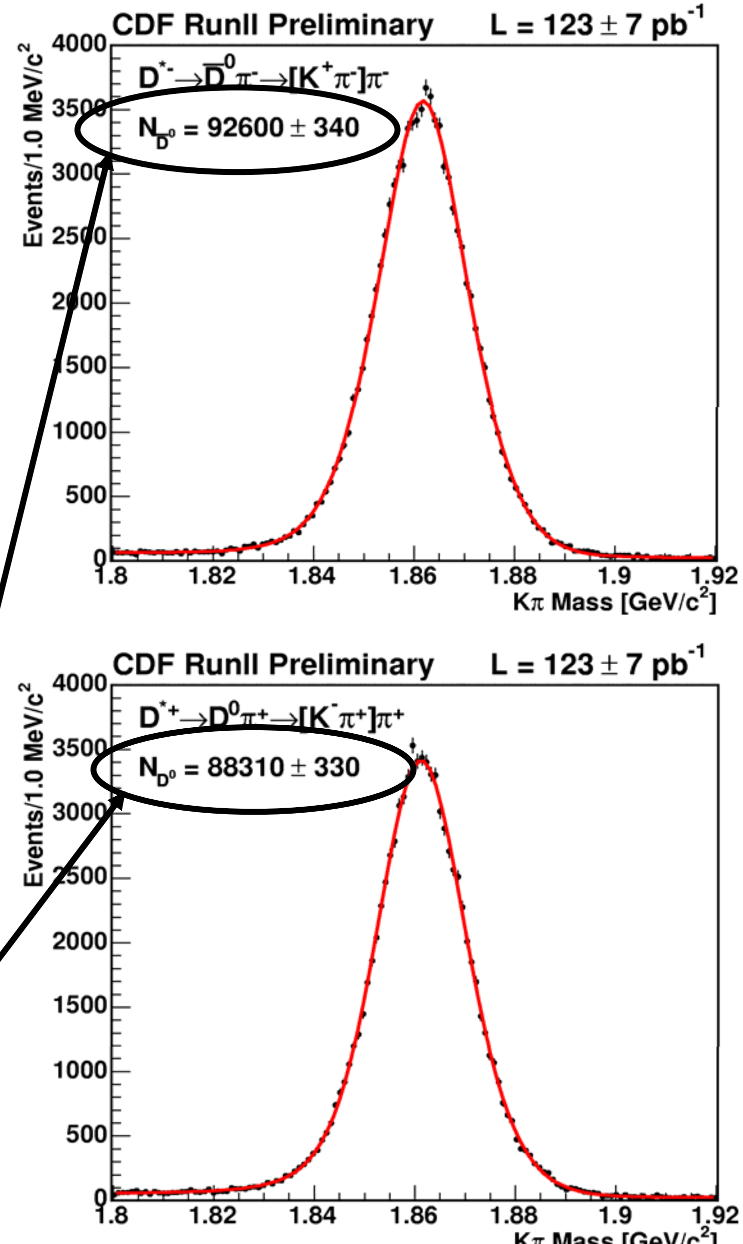
$\Gamma(D^0 \rightarrow \pi^+\pi^-) / \Gamma(D^0 \rightarrow K\pi)$

$\Gamma(D^0 \rightarrow KK) / \Gamma(D^0 \rightarrow \pi\pi) \sim 2.8$ (SM)

Direct CP-violating decay rate assymetries:

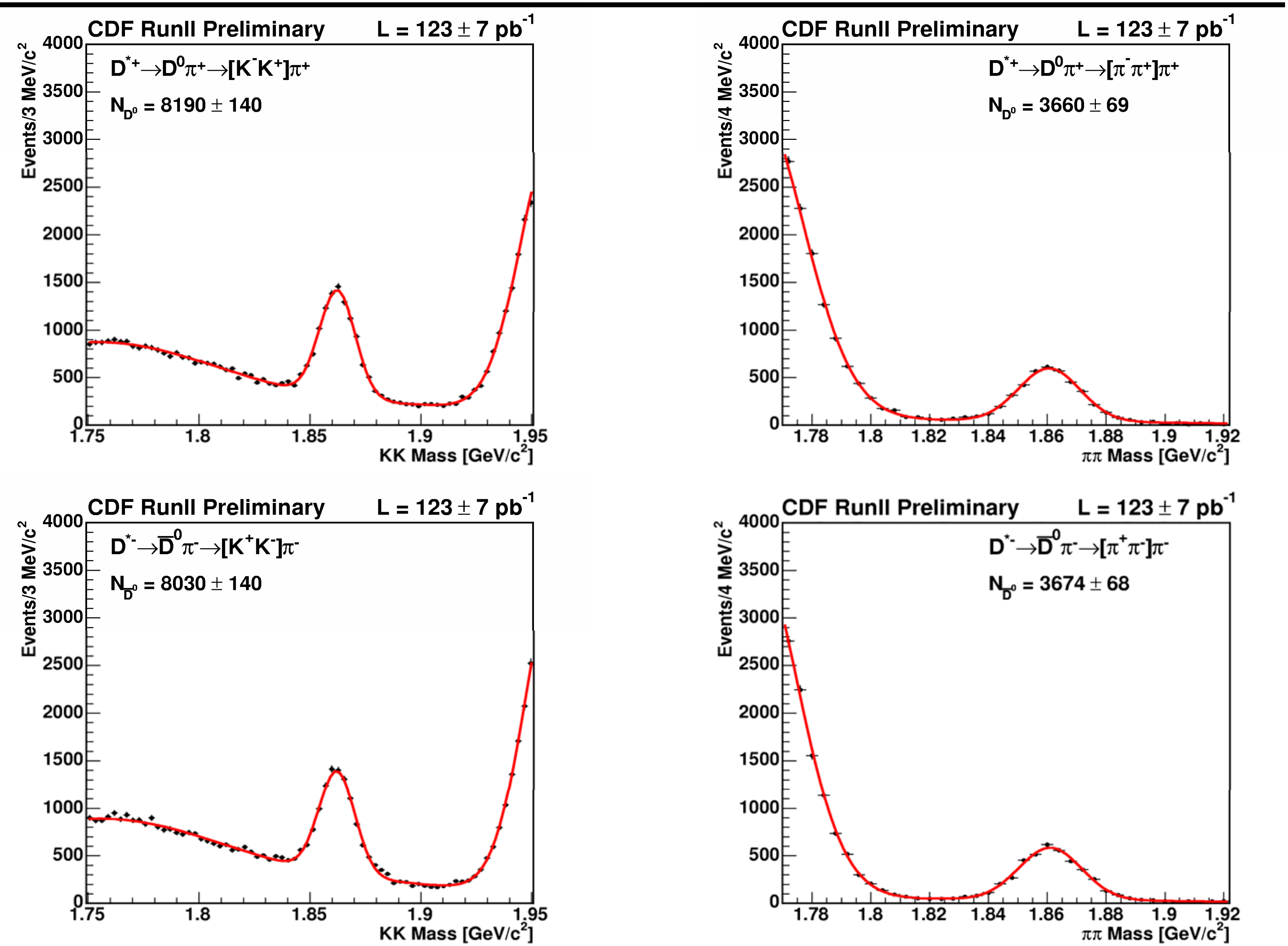
$$A_{CP} = \frac{\Gamma(D^0 \rightarrow f) - \Gamma(\overline{D}^0 \rightarrow f)}{\Gamma(D^0 \rightarrow f) + \Gamma(\overline{D}^0 \rightarrow f)} \approx 0(SM)$$

•Candidates selected as: $D^{*+/-} \rightarrow D^0\,\pi$ (unbiased tag of the D^0 flavor)



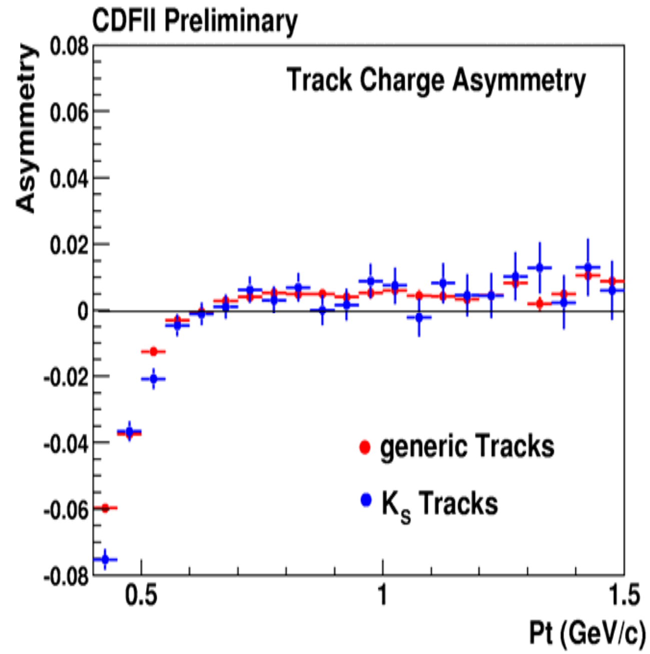
~2 X 90000 $D^{*+/-}$!!!

CP Asymmetries and Decay Rate Ratios



CP Asymmetries and Decay Rate Ratios

Very important to understand the asymmetry of the CDF detector!!!



Results are computed after applying a correction for the intrinsic charge asymmetry of the detector response and tracking algorithms

Ratio	CDF	FOCUS
$\Gamma(D^0 \to KK)/\Gamma(D^0 \to K\pi)$	(9.96 +/- 0.11 +/- 0.12)%	(9.93 +/- 0.14 +/- 0.14)%
$\Gamma(D^0 \to \pi\pi)/\Gamma(D^0 \to K\pi)$	(3.608 +/- 0.054 +/- 0.040)%	(3.53 +/- 0.12 +/- 0.06)%
$\Gamma(D^0 \to KK)/\Gamma(D^0 \to \pi\pi)$	(2.762 +/- 0.040 +/- 0.034)%	(2.81 +/- 0.10 +/- 0.06)%

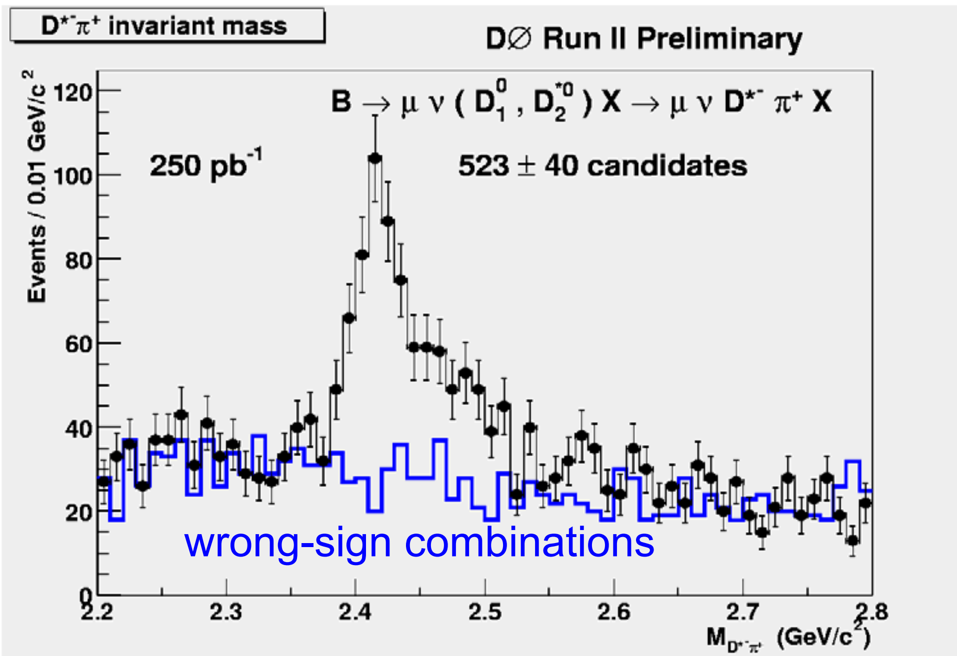
$A(D^0 \to KK)$ = (2.0 +/- 1.2 (stat.) +/- 0.6 (syst.))%
$A(D^0 \to \pi\pi)$ = (1.0 +/- 1.3 (stat.) +/- 0.6 (syst.))%

CLEO-II

$A(D^0 \to KK)$ = (0.0 +/- 2.2 (stat.) +/- 0.8 (syst.))%
$A(D^0 \to \pi\pi)$ = (1.9 +/- 3.2 (stat.) +/- 0.8 (syst.))%

Observation of $B \to \mu\, \nu\, D^{**}\, X$

Start from "$B \to \mu\, \nu\, D^{*-} + X$" sample, and "reconstruct another π^{+}".
Look at mass of $D^{*-}\, \pi^{+}$ system.



Excess in right-sign combinations can be interpreted as combined effect of $D_1^{\,0}$ and $D_2^{\,*0}$

Work in progress: extract separate amplitude, phase for each state

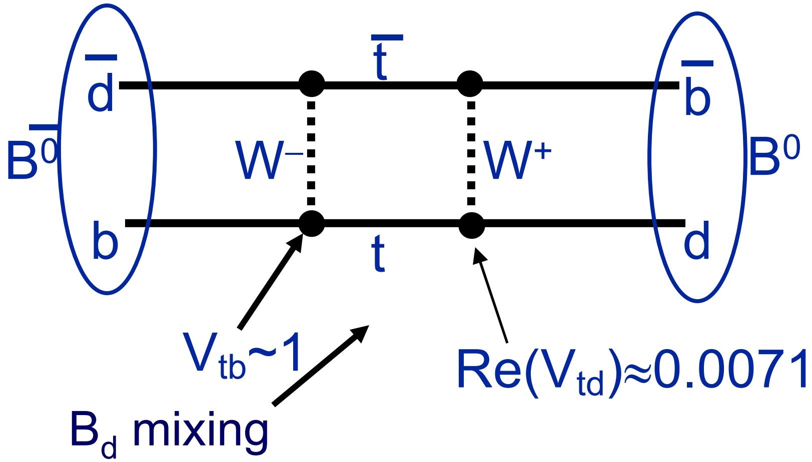
From topological analyses at LEP we know:

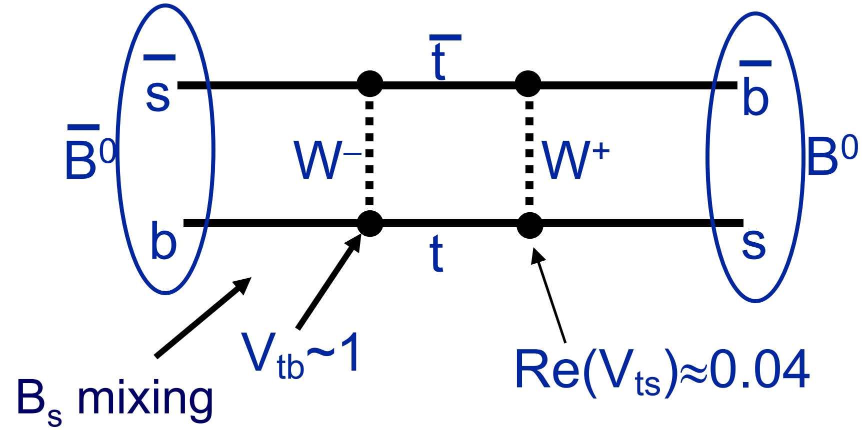
$Br(B \to D^{*+}\, \pi^{-}\, \mu\, \nu\, X) = 0.48 \pm 0.10\ \%$

DØ's preliminary result constrains the resonant contribution

$Br(B \to \{D_1^{\,0}, D_2^{\,*0}\}\ \mu\, \nu\, X) \cdot Br(\{D_1^{\,0}, D_2^{\,*0}\} \to D^{*+}\, \pi^{-}) = 0.280 \pm 0.021\ (stat) \pm 0.088\ (syst)\ \%$

$B^0/\overline{B}^0$ Mixing





The B^0/B^0 mixing frequency Δm_d has been measured with high precision, most recently at the B factories. Measurements of Δm_d constrain $|V_{td}|$, but current limitations are due to theoretical inputs.

Why is B^0 Mixing analysis so important?:

- Benchmark the initial state flavor tagging
- A step toward B_s Mixing

Semileptonic B decays (D0, CDF analysis in progress)
Fully reconstructed B decays (CDF)

B Mixing Measurement

"Ingredients" to get a $B_{(d,s)}$ mixing measurement:

- Measure proper decay time:

$$c\tau = \frac{L_{xy}}{\beta\gamma} = \frac{L_{xy}\, m(B)}{P_T(B)} \quad \rightarrow \quad \sigma_{ct} = \frac{m(B)}{P_T(B)}\sigma_{L_{xy}} \oplus c\tau\left(\frac{\sigma_{P_T(B)}}{P_T(B)}\right)$$

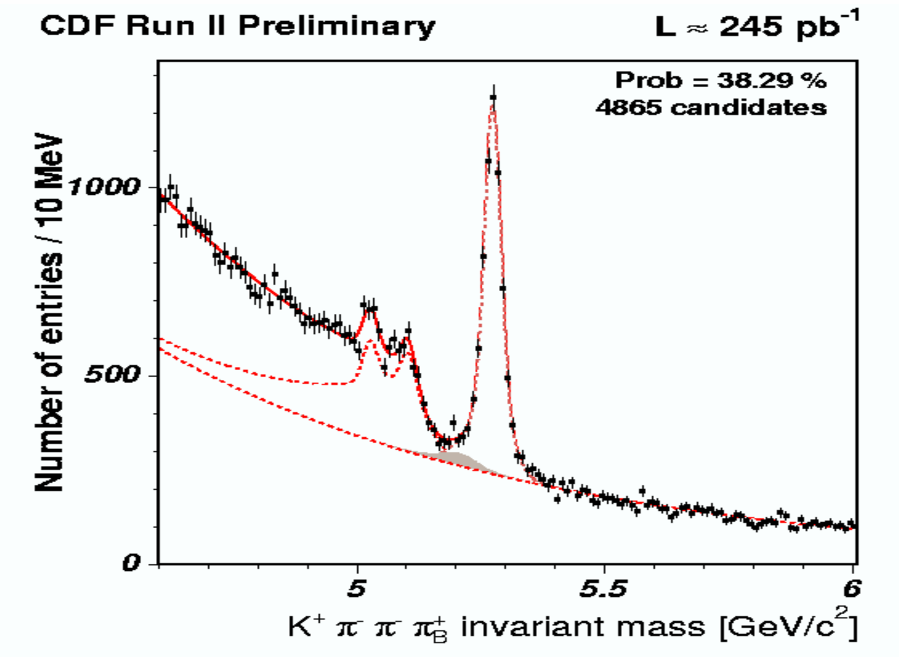
- Identify B flavor at decay:

  Reconstruct the final state with good S/B
  (precise tracking, vertexing, particle ID)

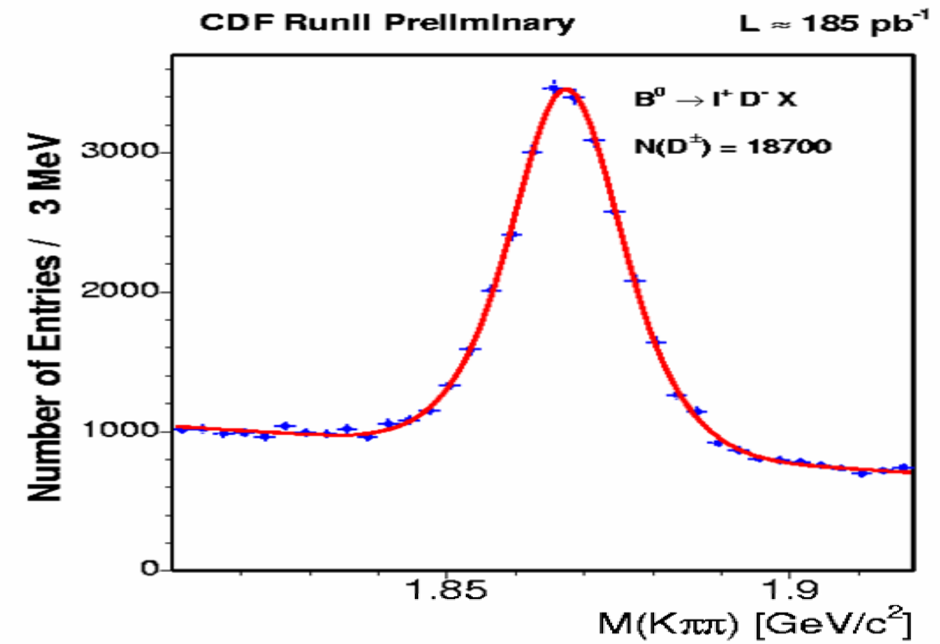
- Identify the flavor of B at production:

  B - flavor tagging algorithms

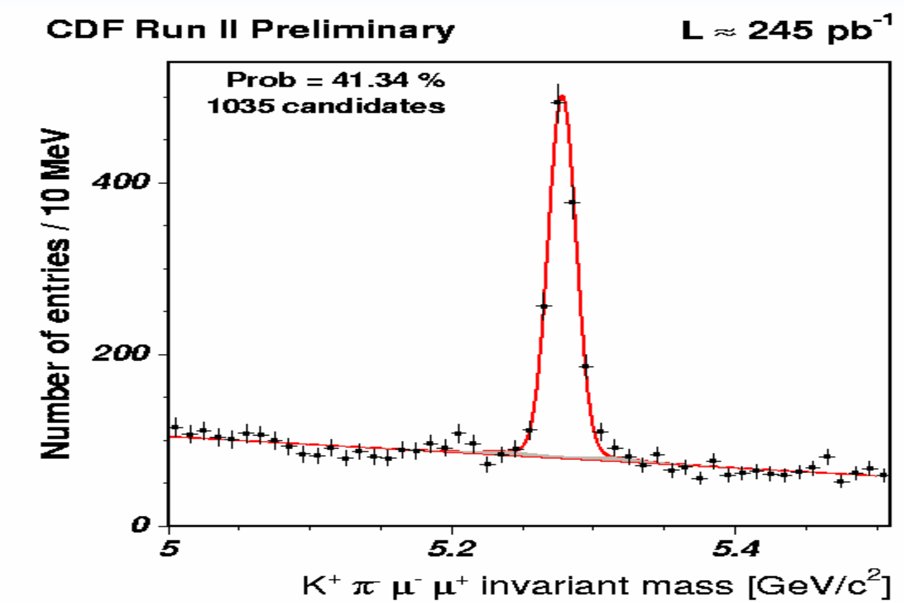
B^0 yields



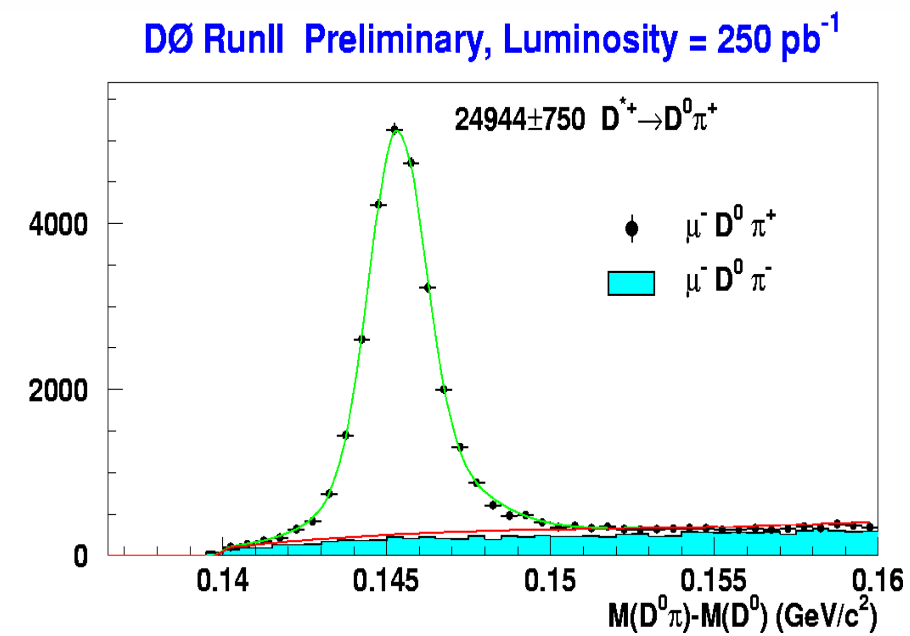
CDF Run II Preliminary
L ≈ 245 pb-1
Prob = 38.29 %
4865 candidates
Number of entries / 10 MeV
1000
500
0
5
5.5
6
K+ π- π- π+B invariant mass [GeV/c2]



CDF RunII Preliminary
L ≈ 185 pb-1
B0 → l+ D- X
N(D±) = 18700
Number of Entries / 3 MeV
3000
2000
1000
0
1.85
1.9
M(Kππ) [GeV/c2]



CDF Run II Preliminary
L ≈ 245 pb-1
Prob = 41.34 %
1035 candidates
Number of entries / 10 MeV
400
200
0
5
5.2
5.4
K+ π- μ- μ+ invariant mass [GeV/c2]



DØ RunII Preliminary, Luminosity = 250 pb-1
24944±750 D*+→D0π+
μ- D0 π+
μ- D0 π-
4000
2000
0
0.14
0.145
0.15
0.155
0.16
M(D0π)-M(D0) (GeV/c2)

Mixing and Flavor Tagging

Figure of merit: εD^2

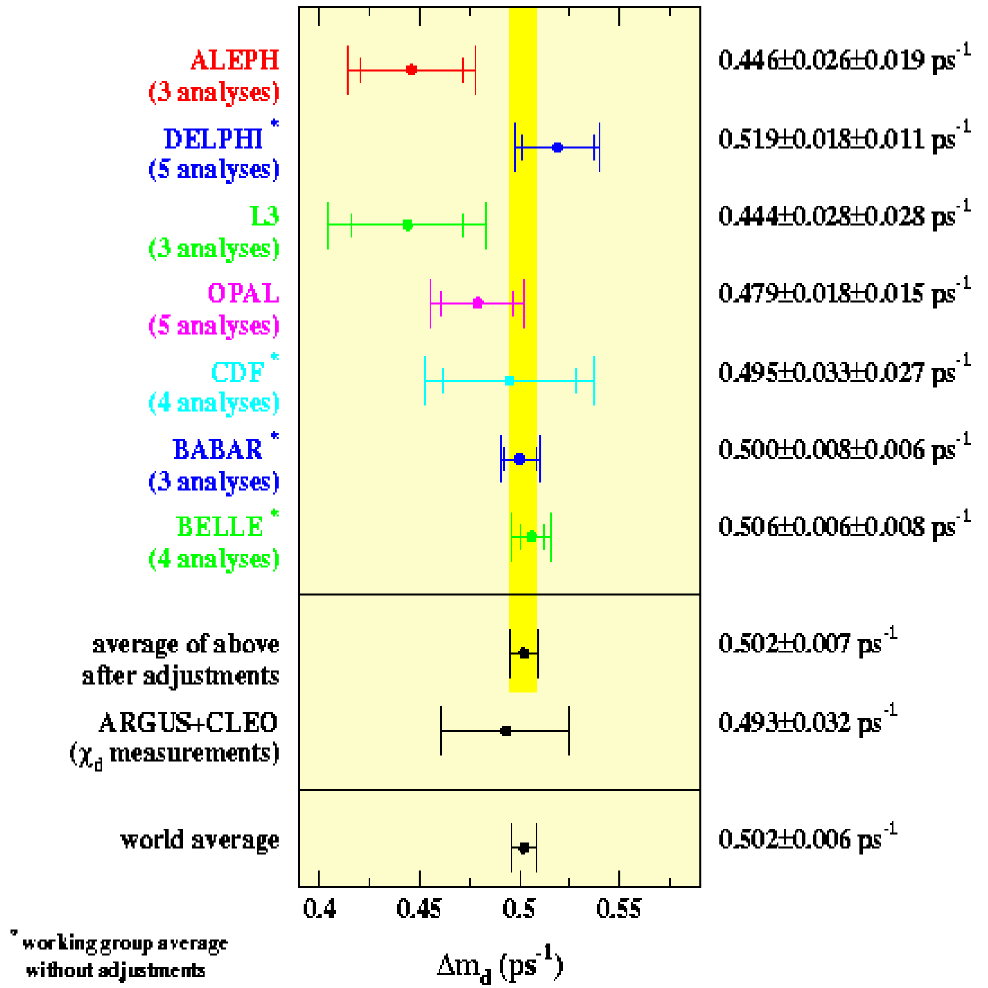
- ε: **tag efficiency**
- **D: dilution**

$$A(t) \equiv \frac{N_R(t) - N_W(t)}{N_R(t) + N_W(t)} = D\cos(\Delta m t)$$

$$A \equiv \frac{N_R - N_W}{N_R + N_W} = D = 1 - 2P_{Tag}$$

- Strategy:
  - use data for calibration (*e.g.* $B^{\pm}\rightarrow J/\psi K^{\pm}$, $B^{\pm}\rightarrow D^0\pi^{\pm}$, $B\rightarrow$lepton…)
  - allow to measure ε, D and εD^2 in data and optimize the taggers
  - can then apply them in any sample without bias

***High precision measurement in B_d* mixing**

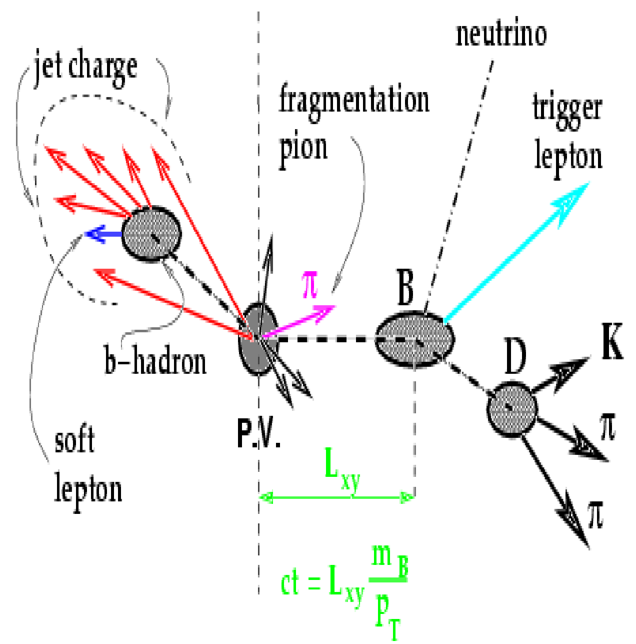


Flavor Tagging algorithms

OST (Opposite Side Tagging):

B's are produced in pairs → measure flavor of opposite B

Opposite side   Same side

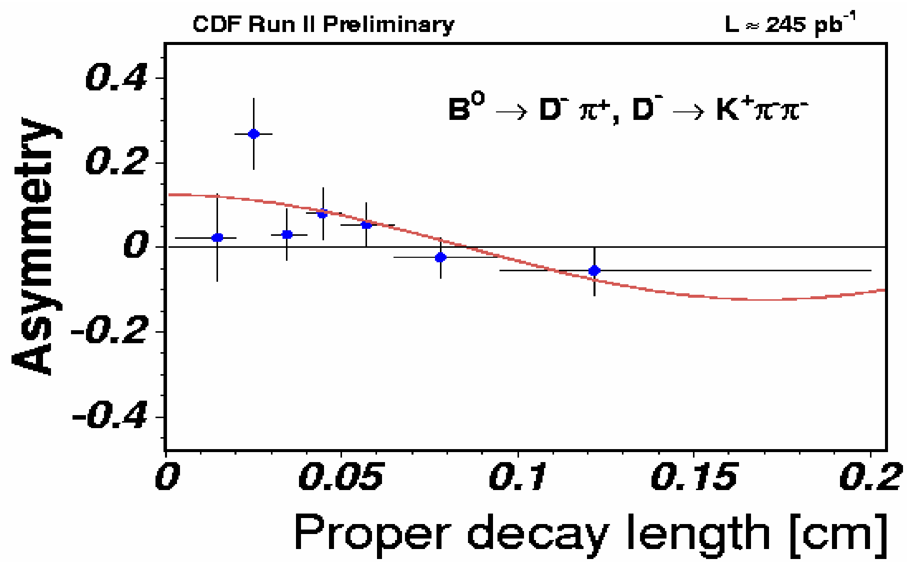


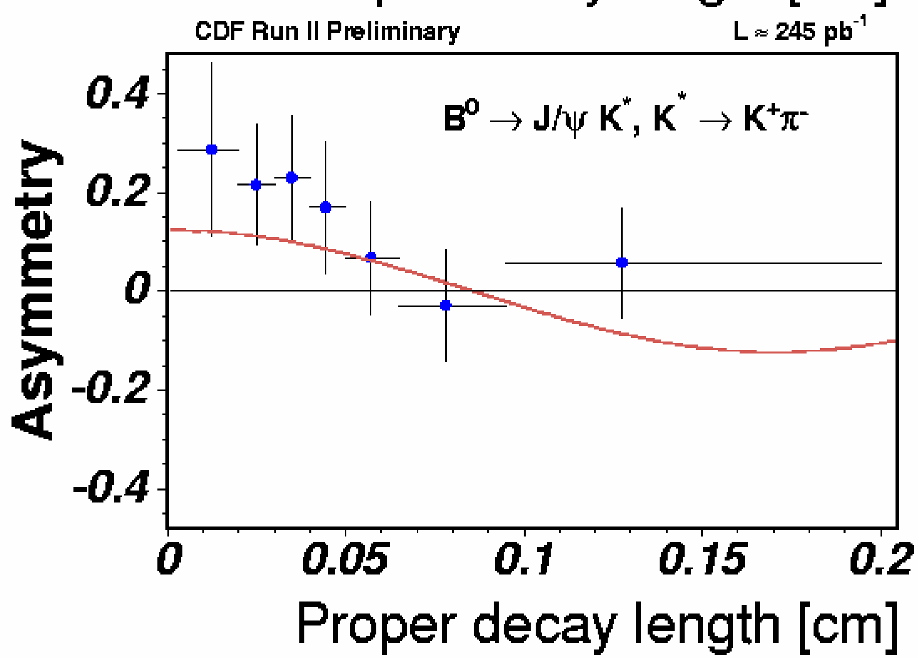
- **JETQ**: sign of the weighted average charge of opposite B-Jet
- **(*) SLT**: identify the soft lepton from semileptonic decay of opposite B
- **Opposite Side K**: due to **b→c→s** it is more likely that a **B** meson will contain in final state a K^+ than a K^-. Identify K^- in the opposite side

SST (Same Side Tagging):

- **(*) SS pion T**: B^0 is likely to be accompanied close by a π^+ from fragmentation
- **SS Kaon T**: B_s is likely to be accompanied close by a K^+ from fragmentation

B^0 mixing results from CDF





CDF uses fully reconstructed B^0 decays to measure Δm_d:

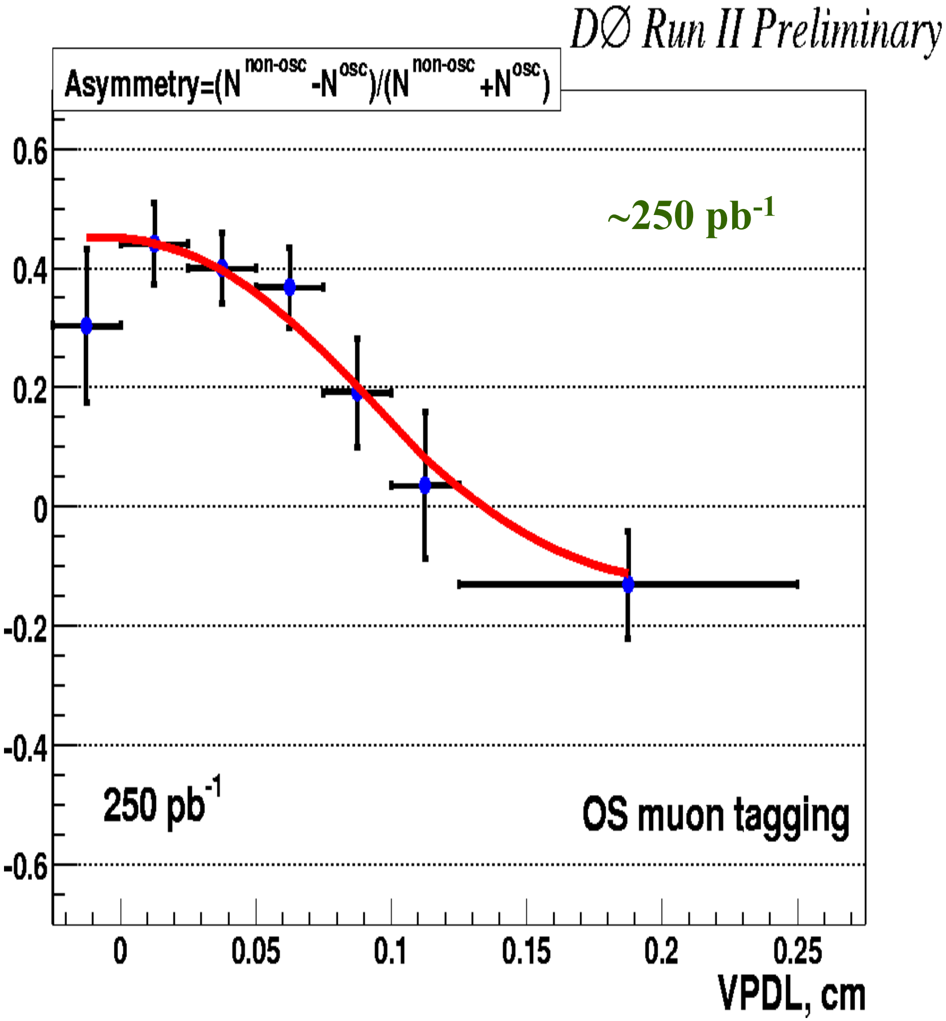
- This analysis uses Same-Side Pion Tag
- **Preliminary results:**

$\Delta m_d = 0.55 \pm 0.10$ (stat.) $\pm$ 0.01 (syst.) ps^{-1}

Work in progress:

- improve SST
- other tagging methods:
  - JQT, SMT, SET
- add more fully reconstructed decay channels
- use semileptonic B decays!

B^0 mixing results from D∅



D0 uses a large sample of semileptonic B^0 decays to measure Δm_d:

- This analysis uses Opposite-Side Muon tag
- **Preliminary results:**

$\Delta m_d = 0.506 \pm 0.055$ (stat.) ± 0.049 (syst.) ps^{-1}

- **Consistent with world average:**
  0.502 ± 0.007 ps^{-1}
- Tagging efficiency: 4.8 ± 0.2 %
- Tagging purity, $N_R/(N_R+N_W) = 73.0 \pm 2.1$ %

Work in progress:

- other tagging methods:
  JQT, SST
- add more decay channel
- add fully reconstructed decays

Pentaquarks searches

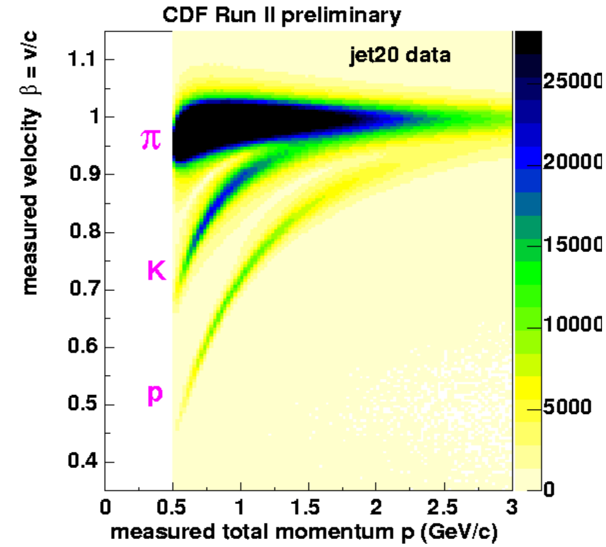
Summary of the new CDF results on the search for Pentaquarks:

CDF has looked at all known channels and has nothing so far

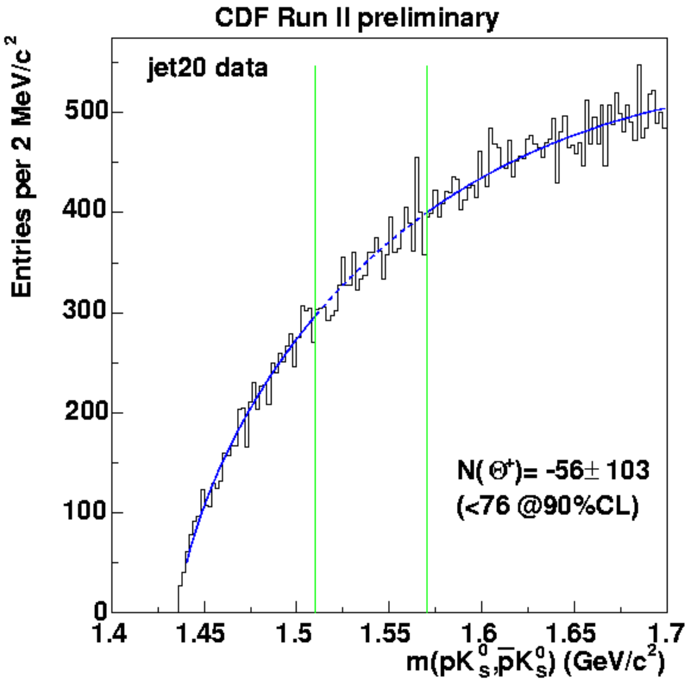
- Channels:
  - $\Theta^+ \rightarrow p\ K_s \rightarrow p\ \pi^+\ \pi^-$
  - $\Xi^0_{3/2} \rightarrow \Xi^-\ \pi^+ \rightarrow \Lambda\ \pi^+\ \pi^-$
  - $\Xi^{--}_{3/2} \rightarrow \Xi^-\ \pi^- \rightarrow \Lambda\ \pi^-\ \pi^-$
  - $\Theta_c \rightarrow D^{*-}\ p \rightarrow D^0\ \pi^-\ p$

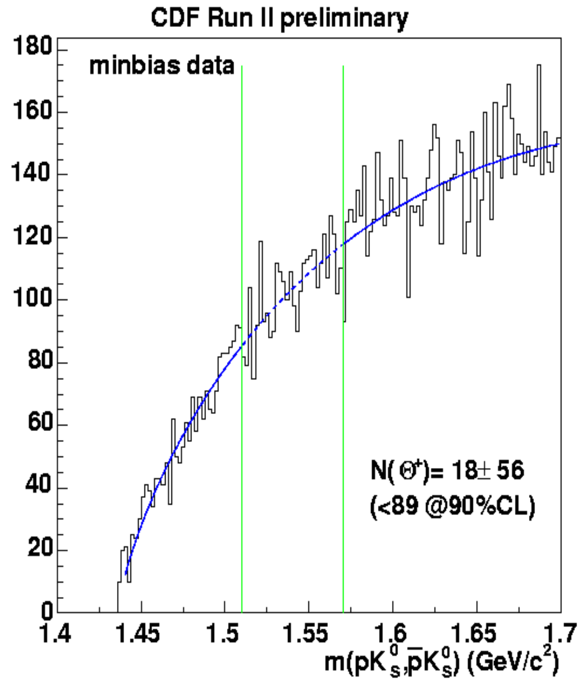
Search for $\Theta^+ \rightarrow p\, K_s$

- Use 2 energy ranges (min bias and jet20)
- Identify protons using TOF



No evidence for narrow resonance

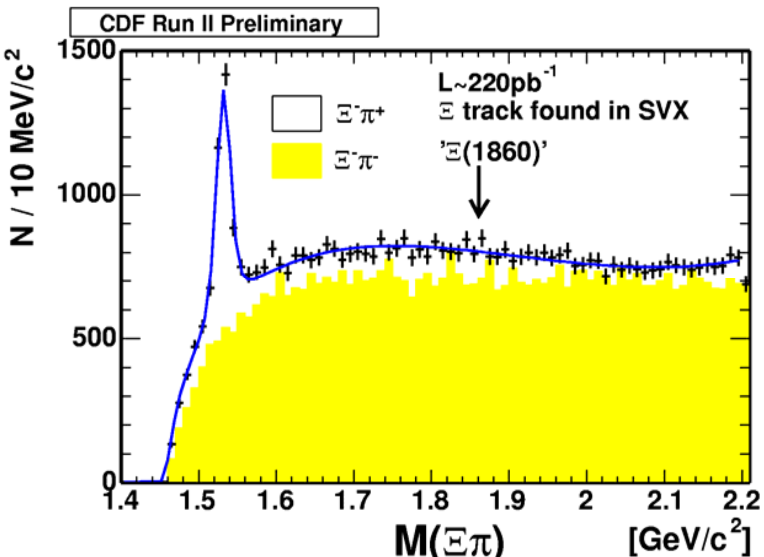




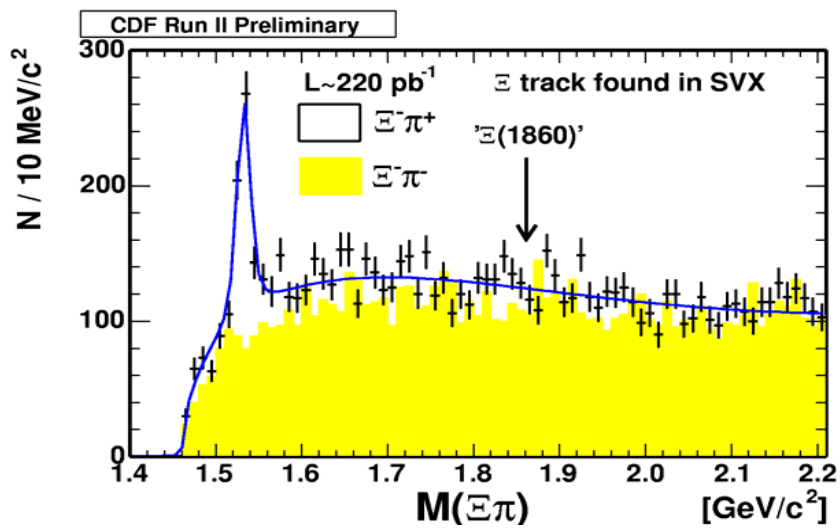
CDF is working on limit for s ($\Theta^+/\Lambda(1520)$)

Search for $\Xi^{0/--}_{3/2} \rightarrow \Xi\,\pi$

- CDF has developed tracking of long lived hyperons in the SVX detector
- Silicon tracking of hyperons improves momentum and impact parameter resolution as well as background reduction



Two Track Trigger



Jet20

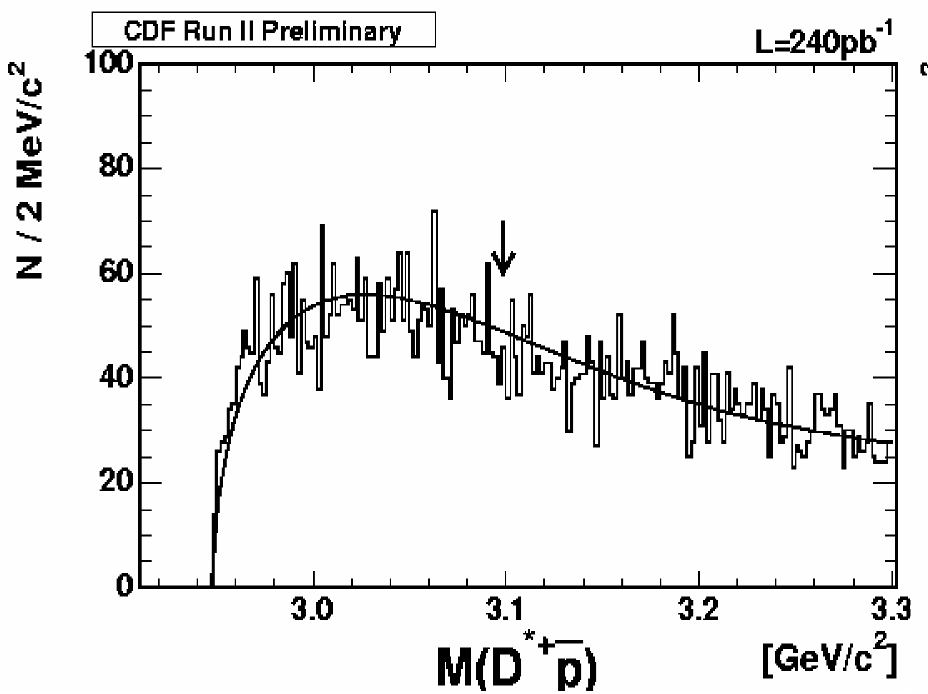
No excess is observed in the CDF data

Channel (TTT)	# of events	$R(\Xi_{1860}/\Xi_{1530})$ U. L. 95% C.L.	$R(\Xi_{1860}/\Xi_{1530})$ NA49
$\Xi^-\pi^+$	57+/-51	0.07	~0.21
$\Xi^-\pi^-$	-54+/-47	0.04	~0.24
$\Xi^-\pi^{+/-}$	47+/-70	0.08	~0.45

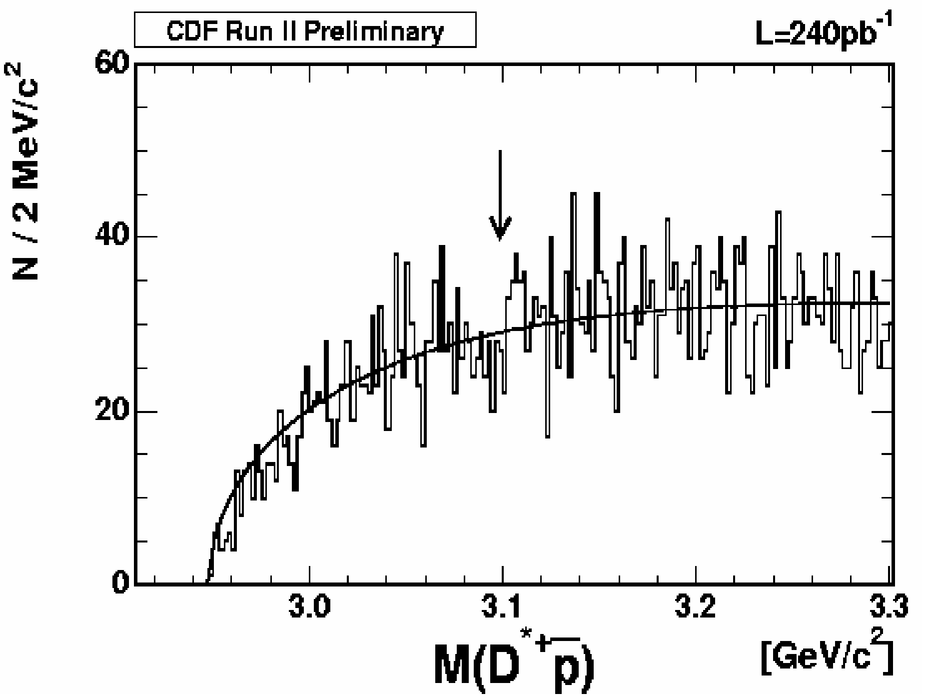
Search for $\Theta_c \rightarrow D^{*-} p$

- Identify protons using TOF (p<2.75 GeV/c) or dEdx (p > 2.75 GeV/c)
- Large sample of D^{*-} (0.5M)

  - **No evidence of charmed Pentaquark seen**
  - **Combined upper limit: < 29 events (90% C.L.)**



TOF



dEdx

Summary

• **Inclusive cross-section measurements agree, within the errors, with the theoretical expectations**

Results in Mev/c^2	CDF preliminary	PDG value
B^+	$5279.10 \pm 0.41 \pm 0.34$	5279.0 ± 0.5
B^0	$5279.57 \pm 0.53 \pm 0.30$	5279.4 ± 0.5
B_s	$5366.01 \pm 0.73 \pm 0.30$	5369.6 ± 2.4
Λ_b	$5619.7 \pm 1.2 \pm 1.2$	5624 ± 9

• **Charm Physics:**

- $A(D^0 \rightarrow KK) = (2.0 \pm 1.2\ (stat.) \pm 0.6\ (syst.))\%$
- $A(D^0 \rightarrow \pi\pi) = (1.0 \pm 1.3\ (stat.) \pm 0.6\ (syst.))\%$
- Observation of narrow D** states in semileptonic B decays

•**B^0 Mixing measurement already established in both experiments, another step toward B_s mixing**

• **No evidence of Pentaquarks in the Tevatron data so far**

Work in progress, stay tuned!

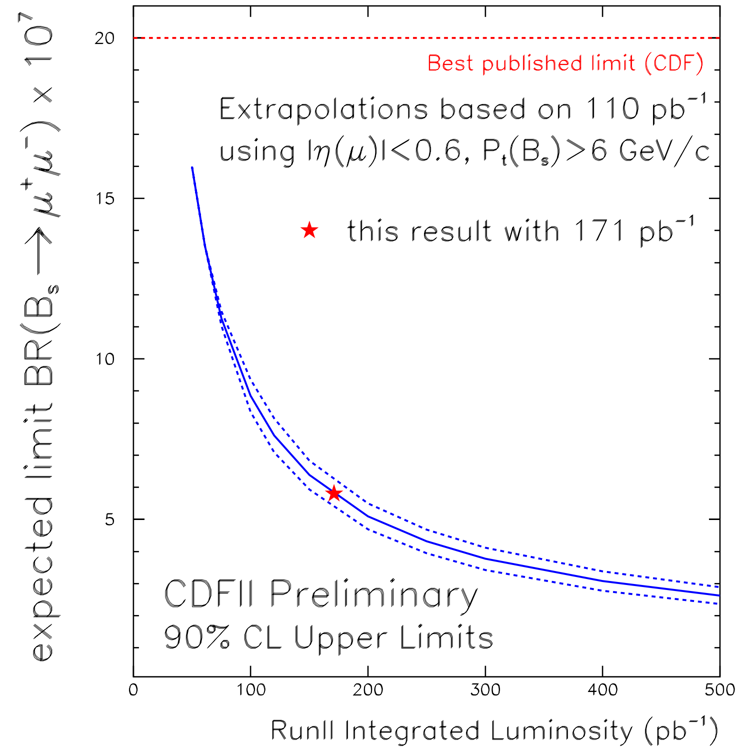
Backup Slides…

Rare B decays: $B_{s(d)} \rightarrow \mu^+\mu^-$ from CDF

- No excess has been found unfortunately
- Limits on the Branching fractions have been set

(Expected/Observed) **BR limits vs. luminosity**

Already Submitted to PRL!



	$B_s \rightarrow \mu^+\mu^-$	$B_d \rightarrow \mu^+\mu^-$
Background	1.05 +/- 0.30	1.07 +/- 0.31
Data	1	1
BR limit @95% C.L.	7.5×10^{-7}	1.9×10^{-7}
BR limit @90% C.L.	5.8×10^{-7}	1.5×10^{-7}

Best world result

Slightly better results than Belle and BaBar

1.6×10^{-7}

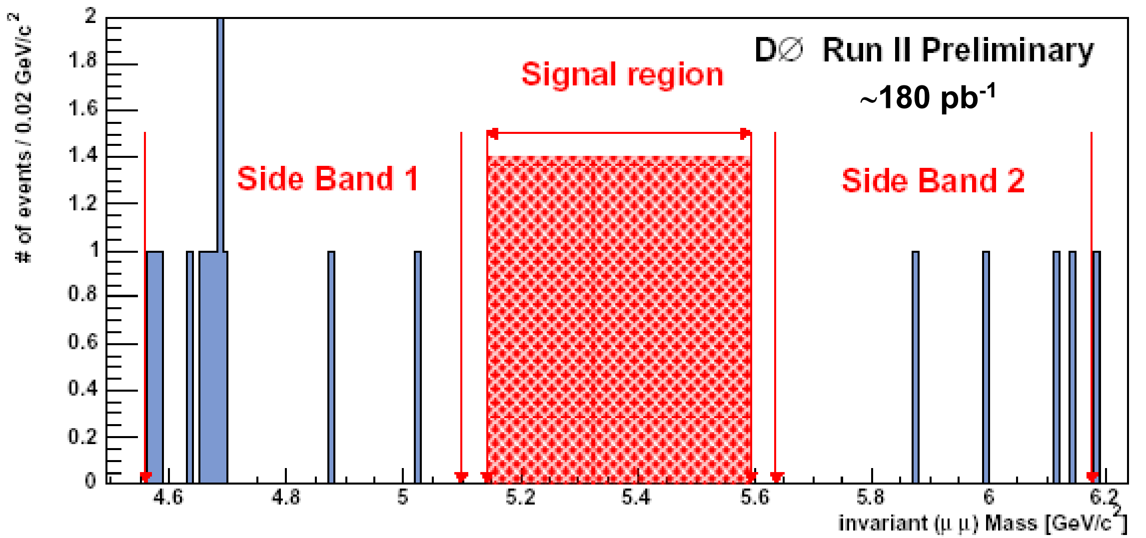
2.0×10^{-7}

$B_s \to \mu^+ \mu^-$ sensitivity study from D0

Optimised cuts using Random Grid Search [Prosper, CHEP'95; Punzi, CSPP'03] based on the mass sidebands

After optimisation:

expect 7.3 ± 1.8 background events in signal region



The analysis has not been *unblinded* yet (signal region still hidden)

Expected limit (Feldman/Cousins):

$Br(B_s \to \mu^+ \mu^-) < 9.1 \cdot 10^{-7}$ @ 95 % CL (stat only)

$Br(B_s \to \mu^+ \mu^-) < 1.0 \cdot 10^{-6}$ @ 95 % CL (stat + syst)

(expected signal has been normalised to $B^\pm \to J/\Psi\, K^\pm$)

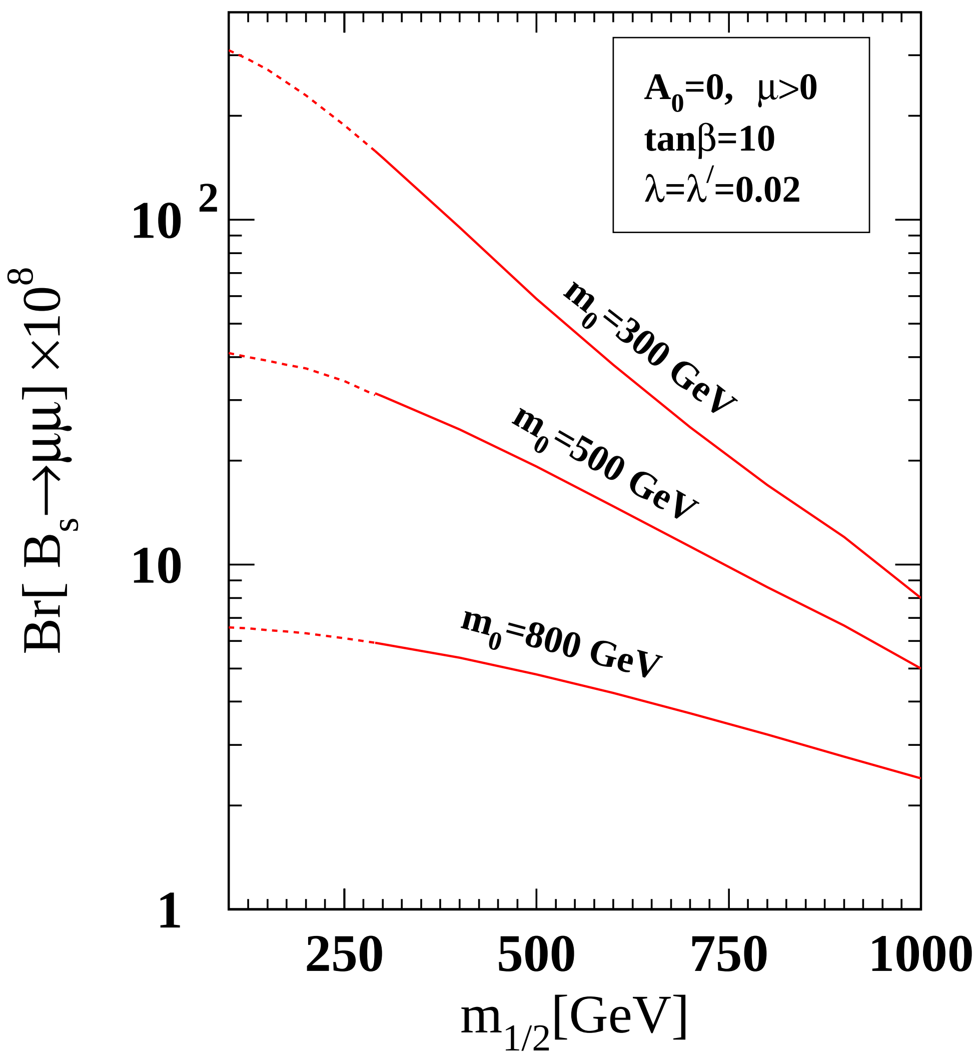
Published CDF Run I result (98 pb^{-1}):

$Br(B_s \to \mu^+ \mu^-) < 2.6 \cdot 10^{-6}$ @ 95 % CL

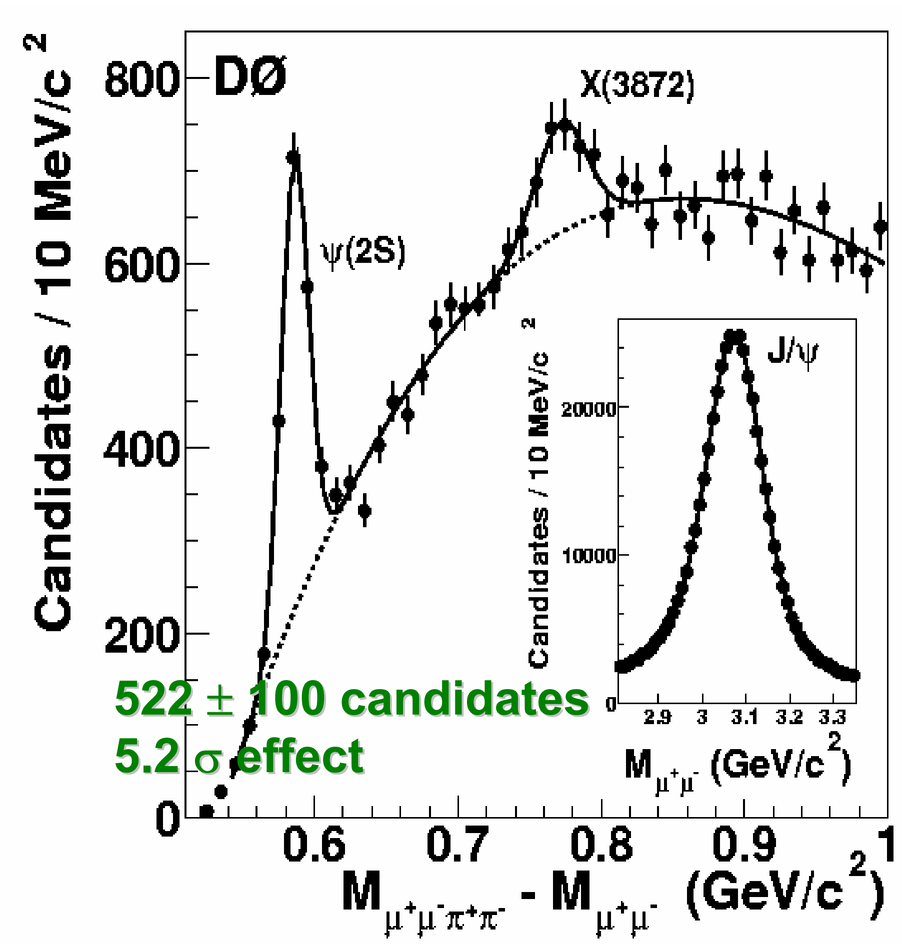
B $_{s(d)} \rightarrow \mu^+\mu^-$ constraints

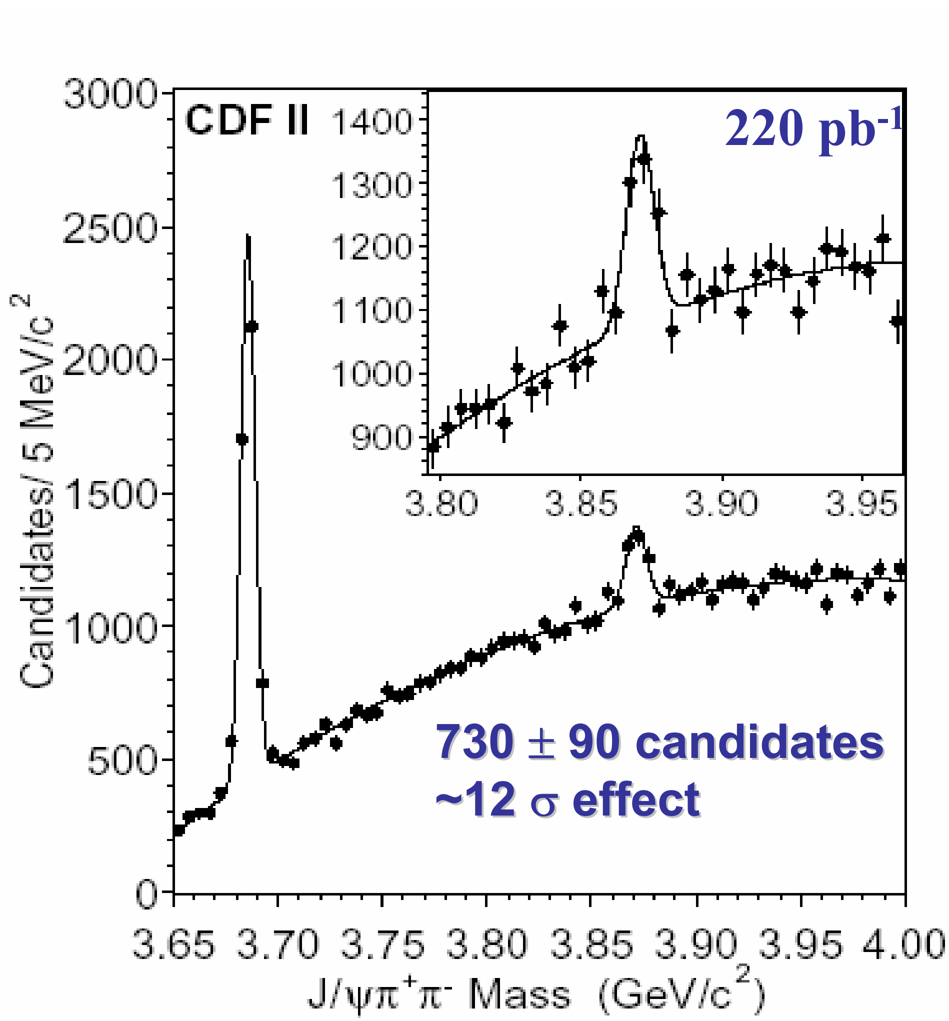
Branching ratio for $B_s \rightarrow$mm as a function of m $_{1/2}$ for m_0 =300,500 and 800 in R-parity violation SUSY scenario. Other mSUGRA parameters are fixed to be tanb=10, A_0=0 and m>0

Dashed lines are to indicate the models that are excluded via b → sγ constraints



Exotic State: X(3872) → $J/\psi\ \pi^+\ \pi^-$





$\Delta M = 774.9 \pm 3.1(\text{stat}) \pm 3.0\ (\text{sys})\ \text{MeV}/c^2$

$\Delta M + M(J/\psi) = 3871.8\ \ \pm 4.3\ \text{MeV}/c^2$

$M_X = 3871.3 \pm 0.7\ (\text{stat}) \pm 0.4\ (\text{sys})\ \text{MeV}/c^2$

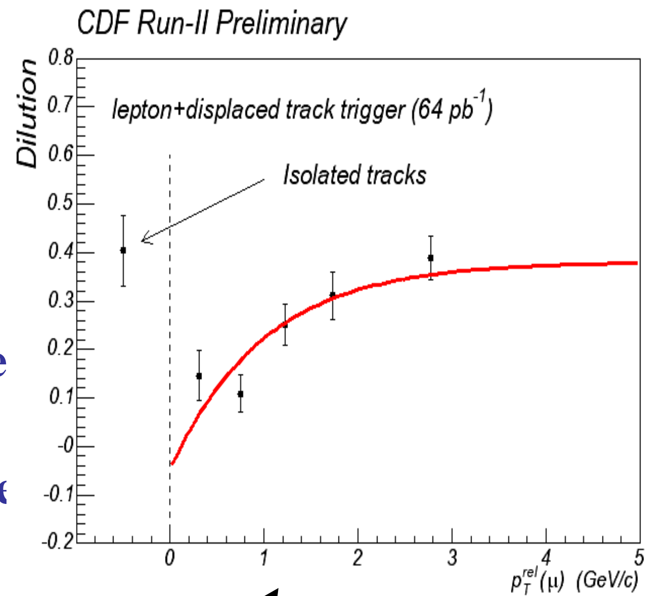
Belle: $M_X = 3872.0 \pm 0.6\ (\text{stat}) \pm 0.5\ (\text{sys})\ \text{MeV}/c^2$

Soft Muon Tag in Semileptonic Sample at CDF

lepton + displaced track trigger provides high statistics sample

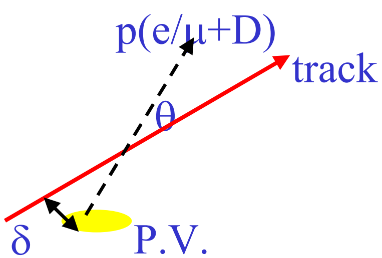
Analysis:

- **Trigger lepton used to estimate B flavor at production**
- **Identify μ charge on opposite side**
- **Cross check consistency with partially reconstructe lepton+$D^{+,0}$**
- **Remainder: this number is UNBIASED since we are using an independent (and high statistics) control sample**



Consistent with RunI

εD^2 **(SMT) = (0.7±0.1)%**

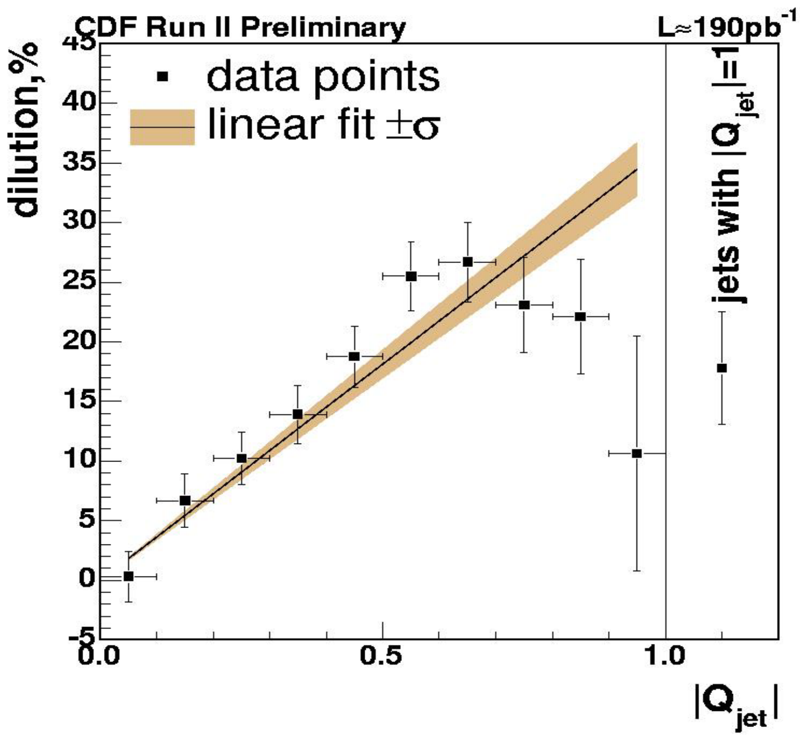


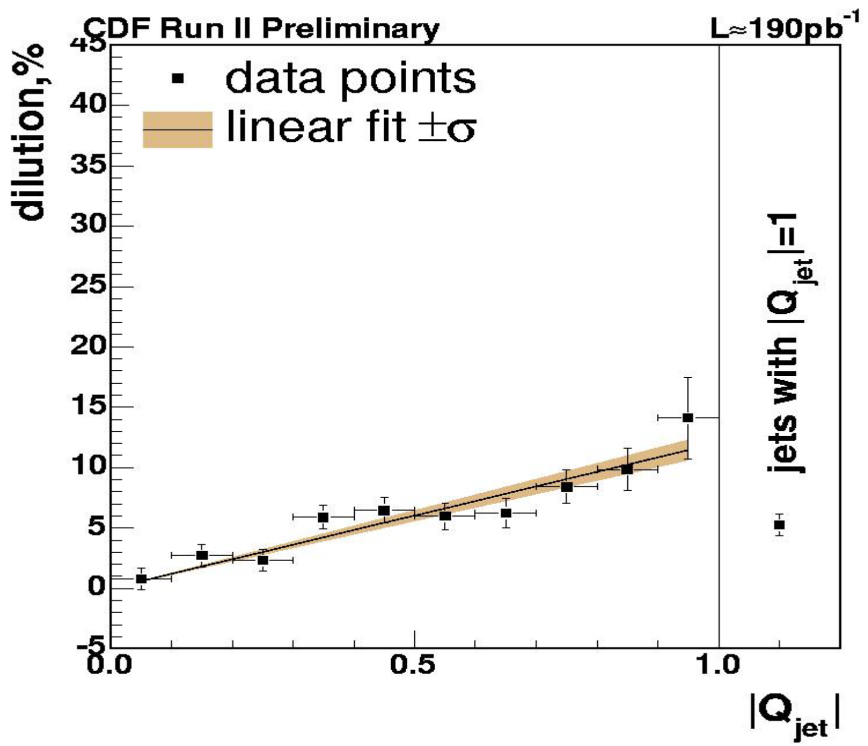
Detailed sample composition studies:

- **Mass cut removes D decays: $2<M(l+track)<4 GeV/c^2$**
- **Background subtraction variable separates B's from background: signed IP of displaced track**

Jet Charge Tag in Semileptonic Sample at CDF

- This work starts from the high-Pt version of the Run I Jet Charge Tagging algorithm.
- The algorithm is applied to and calibrated on the inclusive semileptonic events from the *e*+svt and μ+svt trigger





Jet type	ε, %	D at $\lvert Q_{jet}\rvert$=1, %	ϵD^2, %
e-SVT sample with μ-SVT tuning:			
SecVtx jets	9.9±0.1%	36.7±3.1%	0.226±0.016%
non-SecVtx jets	68.8±0.2%	12.0±1.2%	0.193±0.018%
combined	78.6±0.2%	—	0.419±0.024%

- First step on JQT
- Work in progress to improve it

CPV - Two body charmless decays $B \to h^+h^-$

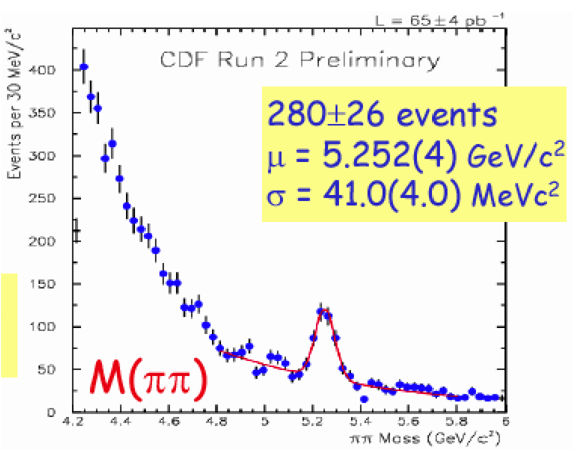
- Time dependent asymmetry $B_d \to \pi\pi$ (α angle) and $B_s \to KK$ (γ angle)
- Direct CP asymmetry of the self tagging modes $B_d \to \pi K$ and $B_s \to K\pi$

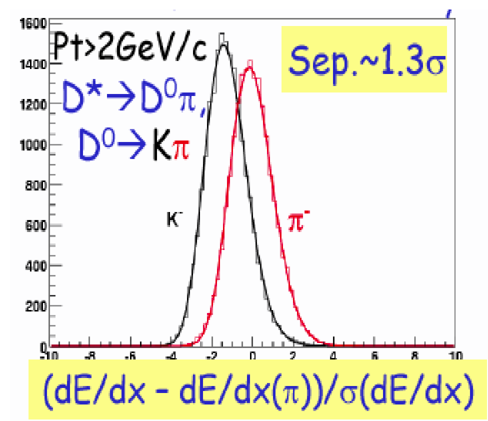
1. extracting the signal

Online hadronic selection
+ B pointing prim. vertex,
displaced & isolated

2. Separation of the components

- dE/dx ~ 1.3s for K/π separation
- Statistical separation is still possible
- Unbinned log-likelihood fit defined including
  - Kinematical variables M(ππ) and a=(1-p1/p2)q1
  - dE/dx





Mode	Yield (65 pb^{-1})
$B^0 \to K\pi$	148±17(stat.) ± 17(syst)
$B^0 \to \pi\ \pi$	39±14(stat.) ± 17(syst)
$B_s \to KK$	90±17(stat.) ± 17(syst)
$B_s \to K\pi$	3±11(stat.) ± 17(syst)

CPV - Direct A_{CP} Selftagging Modes - Projections

- First observation $B_s \to KK$
- Direct A_{CP} violation ~ 0

$$\frac{BR(B_s \to K^\pm K^\mp)}{BR(B_d \to K^\pm \pi^\mp)} = 2.71 \pm 1.15$$

$$A_{CP}(B^0 \to K^- \pi^+) = 0.02 \pm 0.15\,(\mathrm{stat}) \pm 0.02\,(\mathrm{syst})$$

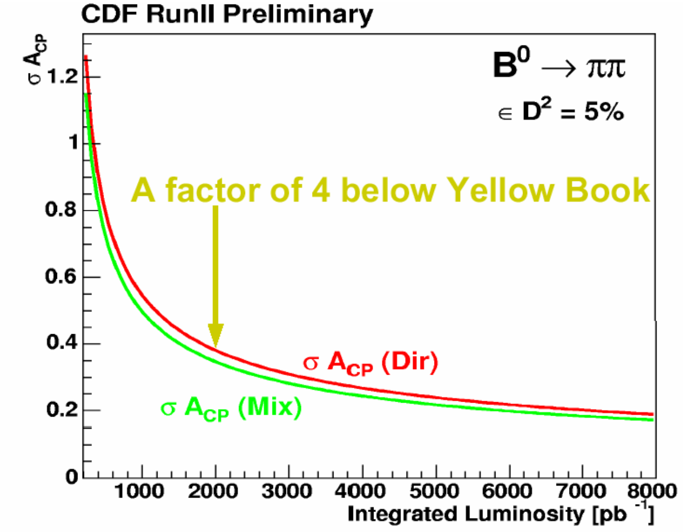
Mode	Yield 2 fb^{-1}	Yield 3.5 fb^{-1}
$B_d \to K\pi$	6700	11,725
$B_d \to \pi\pi$	1770	3097
$B_s \to KK$	4040	7070
$B_s \to K\pi$	1070	1870

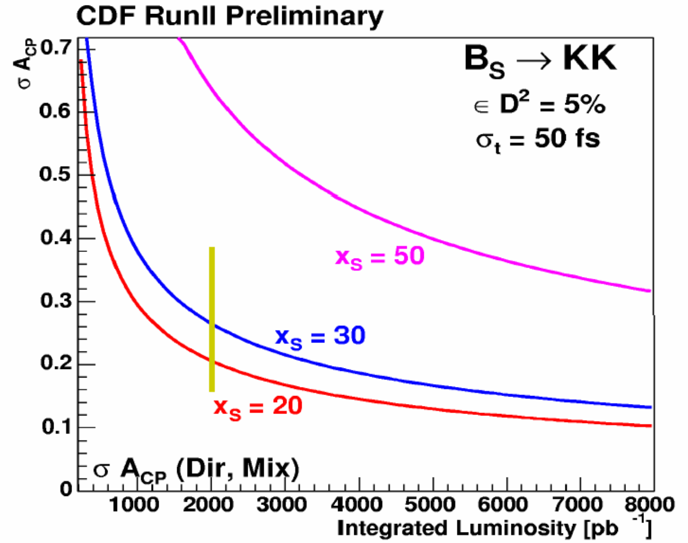
Small

$$A_{CP}(B^0) = A_{CP}^{\mathrm{dir}} \cos \Delta m_d t + A_{CP}^{\mathrm{mix}} \sin \Delta m_d t$$

$$A_{CP}(B_s) = A_{CP}^{\mathrm{dir}} \cos \Delta m_s t + A_{CP}^{\mathrm{mix}} \sin \Delta m_s t$$

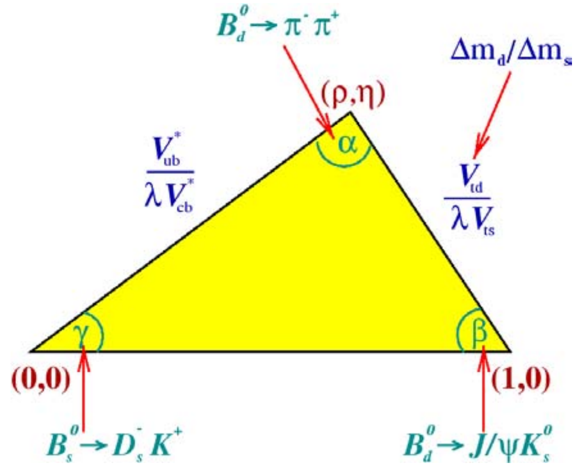
Large but unknown

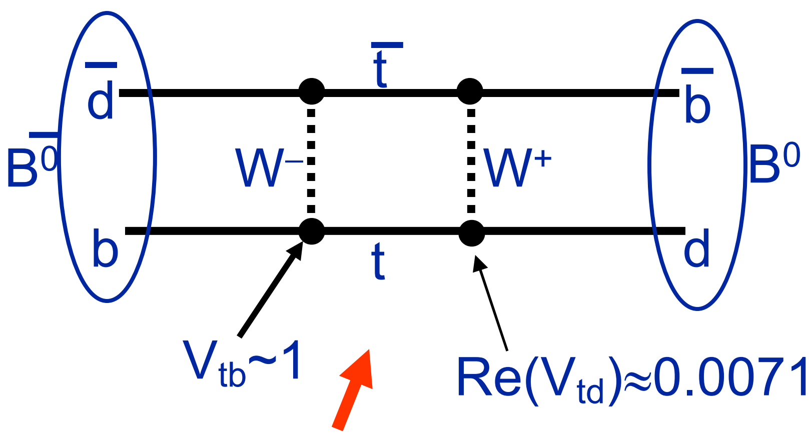




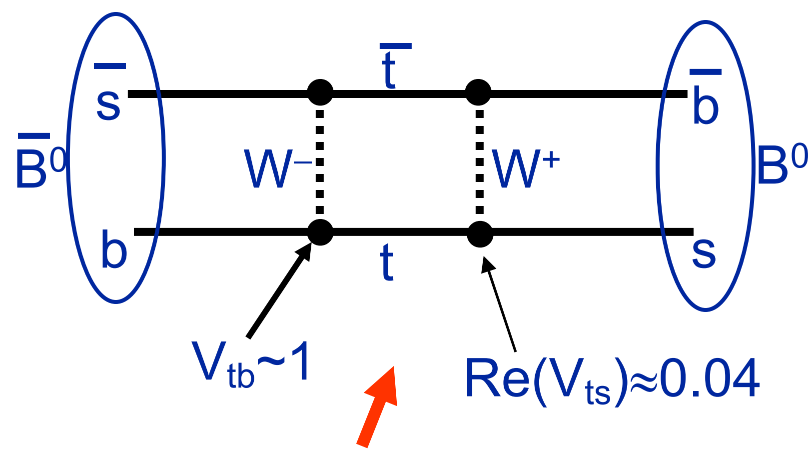
Towards B_s Mixing

- Measurement of Δm_s helps improve our knowledge of CKM triangle
- Combined world limit on B_s mixing
  - –$\Delta m_s > 14.4\,ps^{-1}$ @95%C.L.
  - –**B_s fully mixes in < 0.15 lifetime!**
- B_s oscillation much faster than B_d because of coupling to top quark





B_d Mixing



B_s Mixing

B_s Mixing sensitivity

- D0: 2 fb^{-1}, Δm_s = 15 and s_t = 150 fs
  - Please, be careful with these numbers!
  - Single muon trigger:
    - $B_s \rightarrow D_s\ \mu\ X$ (3.5 σ)
    - $B_s \rightarrow D_s\ e\ X$ (3.5 σ)
    - $B_s \rightarrow D_s\ \pi$ (2.2 σ), μ in the other side
  - Dimuon trigger:
    - $B_s \rightarrow D_s\ \mu\ X$ (3.0 σ), μ in the other side
- CDF:
  - Δm_s = 15, 2 σ limit with 0.5 fb^{-1}
  - Δm_s = 18, discovery with 1.7 fb^{-1}
  - Δm_s = 24, discovery with 3.2 fb^{-1}

Semileptonic decays:

- Very good statistics, but poorer time resolution

- If Δms ≅ 15 ps-1 expect a 1-2 σ measurement with 500 pb-1

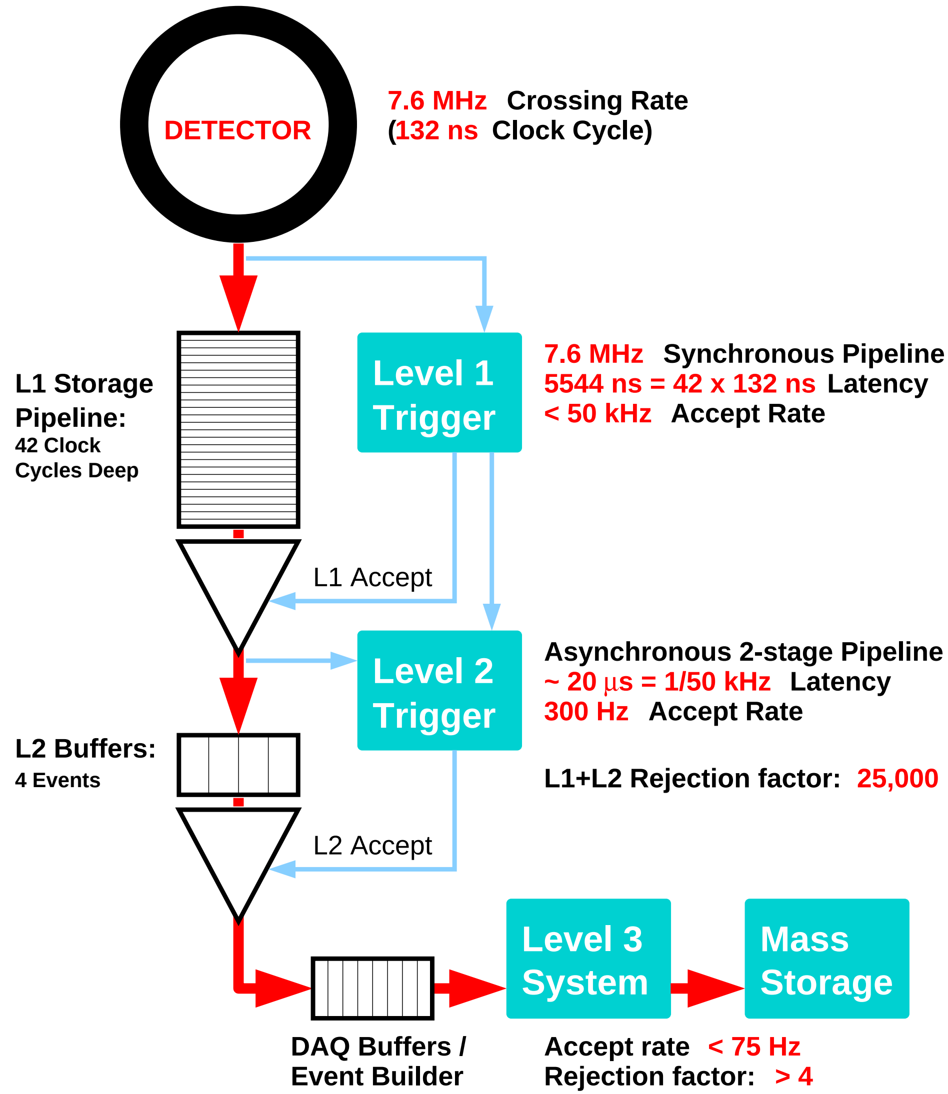
CDF Trigger System Overview

- Crossing: 396 ns, 2.5 MHz

- Level 1: hardware
  - Electron, Muon, track, missing E_t
  - 15-20kHz (reduction ~x200)

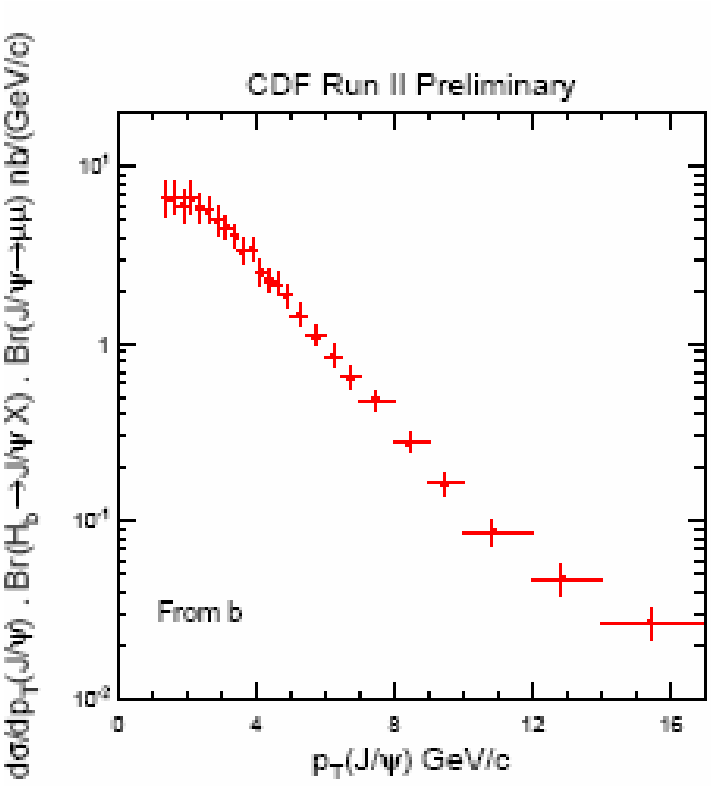
- Level 2: hardware
  - Cal. Cluster, jet finding, Silicon track
  - 300-350 Hz (reduction ~x5)

- Level 3: Linux PC farm
  - ~ Offline quantities
  - 50-70 Hz (reduction ~ x6)



b Hadron Differential Cross Section

$$d\sigma(p\bar{p} \to H_b X, H_b \to J/\Psi X)\cdot Br(J/\Psi \to \mu\mu)/dp_T(J/\Psi)$$



H_b denote both b hadron and anti b hadron

$|Y(H_b)|<0.6$

But:

We can not extract b fraction when b hadron is at rest

We want total b hadron cross section

We want b cross section as a function of b hadron transverse momentum

b Hadron Differential X-Section

Bottom decays transfer about 1.7GeV p_T to the J/Ψ
We can probe b near p_T=0 if we can measure b fraction of J/Ψ with p_T below this value

Assume a b-hadron p_T spectrum

Unfold $p_T(H_b)$ from $p_T(J/\Psi)$ using MC

b-hadron X-section $d\sigma/dp_T(H_b)$

New b-hadron p_T spectrum

Iterate to obtain the correct p_T spectrum

b-hadron differential and total X-section